FOOD TECHNOLOGY

PUBLISHED BY THE INSTITUTE OF FOOD TECHNOLOGISTS

IN THIS ISSUE

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Laboratory Preparation of Potato Granules by Solvent Extraction

Application of Enzymes to Corn Syrup Production

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Occurrence and Nature of Bacteria in Canned Beef

Juice Quality of Delicious Apples as Affected by Method of Fruit Handling

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The Extraction of Pectin from Sunflower Heads

Studies on the Recovery of Essence from Florida Orange Juices

Affairs of the Institute

Pages 297-340

August, 1953 Volume 7, Number 8

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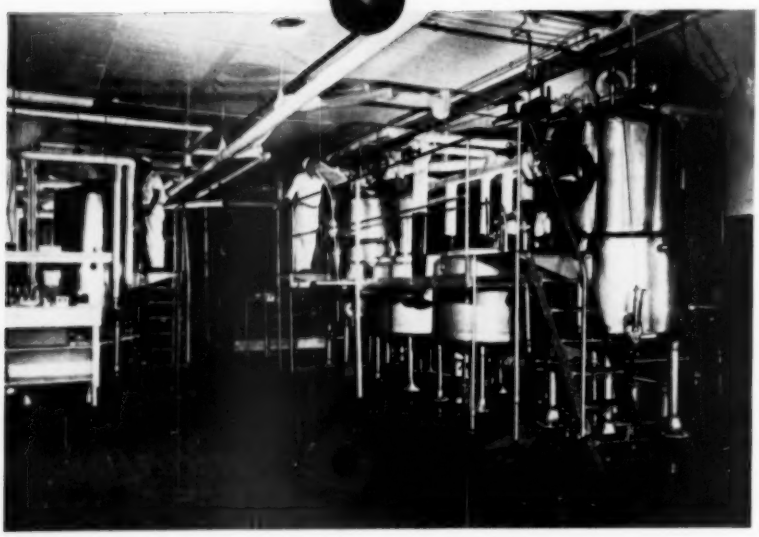

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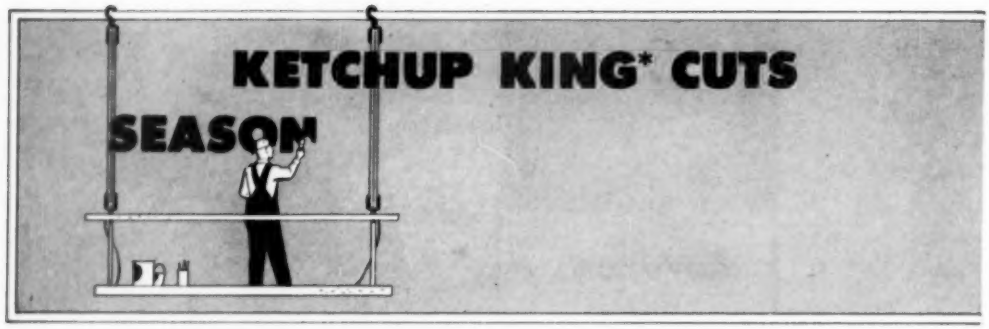

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FOOD TECHNOLOGY

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MARTIN S. PETERSON

Editorial Office: 11606 South Bell Avenue, Chicago 43, Illinois

Consulting Editor Z. I. KERTESZ

Editor Emeritus C. OLIN BALL

Associate Editors

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FRED W. WENZEL

Business Manager

CHARLES S. LAWRENCE

176 West Adams Street, Chicago 3, Illinois

ADMINISTRATIVE DATA AND DIRECTORY

Office of the Editor

11606 South Bell Avenue, Chicago 43

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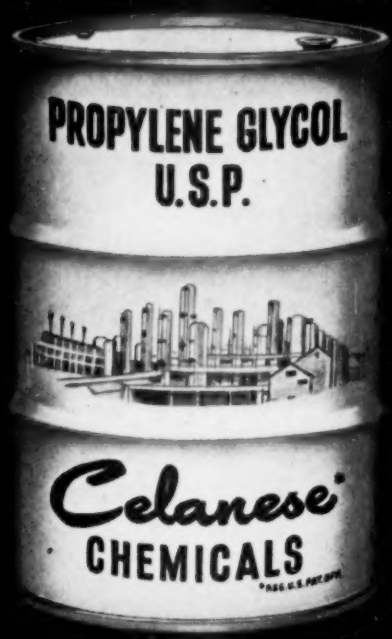

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Affairs of the Institute

Dr. Berton S. Clark Begins Term as President of IFT
Proceedings of the Council
Regional Section News
Books
Selected Abstracts
Annual Meeting Bulletin Board
Food Industry Topics
Future Meetings

Dr. Berton S. Clark Begins Term as President of the Institute of Food Technologists

Dr. Berton Stanley Clark, scientific director of the research and technical department of the American Can Company, received his credentials as president of the Institute of Food Technologists on the final day of the Boston Meetings. Widely known to food technologists from coast to coast, both in the United States, Canada, and overseas, Dr. Clark has given generously of his time and energies to developing and strengthening the professional bonds that hold scientists and technologists in food processing and allied fields together in a common enterprise.

DR. BERTON S. CLARK (right) receives presidential credentials from outgoing president, DR. BERNARD E. PROCTOR, at Boston IFT meetings.

Dr. Clark is not without experience in the leadership of professional groups. As president of the Research and Development Associates in its formative period he contributed substantially toward making the postwar research and development program of the Quartermaster Corps on foods and containers productive and effective. He has long been a consultant to the Quartermaster General and to the Department of Agriculture and has been uniquely able, in these roles, to furnish both the industrial and the scientific viewpoints in councils on food technology problems. Owing to his native modesty, it is likely that Bert Clark would disavow the foregoing temperate praise. There is, however, ample testimony indicating the high regard in which his counsel is held.

Dr. Clark, who holds his degrees from St. Lawrence University, has worked and published extensively in the chemical field (the hydrogen evolution test) in canning technology (tin plate standardization; corrosion resistant tin plate) and in the field of food technology, where he has worked on the improvement of food products and their packaging. He is an active member of the American Chemical Society, The American Institute of Physics, The American Public Health Association, the Industrial Research Institute, and the National Farm Chemurgic Council. He has served in various capacities in the National Canners Association and as chairman of the Technical Committee of the Can Manufacturer's Institute.

The Institute of Food Technologists, always fortunate in the calibre of men elected to administer its affairs, will have in President Berton S. Clark an effective leader, a tireless worker, and a man devoted to the professional traditions, ideals, and standards so firmly established in the Institute of Food Technologists.

M. S. P.

Condensed Proceedings of the Meeting of the Council

INSTITUTE OF FOOD TECHNOLOGISTS, THE STATLER HOTEL BOSTON, MASSACHUSETTS, JUNE 21, 1953

Present

B. E. Proctor, President
B. S. Clark, President-Elect
C. N. Frey, Past President
L. E. Clifcorn, Councilor-at-Large
L. A. Hall, Councilor-at-Large
W. B. Esselen, Councilor-at-Large
R. B. Wakefield, Councilor-at-Large
H. C. Diehl, Councilor-at-Large
G. F. Garnatz, Councilor-at-Large
H. S. Mitchell, Councilor-at-Large
G. E. Brissey, Chicago
W. J. Mutschler, Chicago
J. M. Jackson, Chicago
R. F. Cohee, Chicago
D. A. Huber, Chicago
H. T. Griswold, No. Calif.
E. Jacobs, No. Calif. (alt.)
E. Mrak, No. Calif. (alt.)
M. E. Highlands, Northeast
A. S. Levine, Northeast (alt.)
M. E. Powell, So. Calif. (alt.)
M. S. Burns, So. Calif. (alt.)
C. M. Harrold, St. Louis
J. H. Nair, New York
F. C. Baselt, New York
F. W. Wenzel, Florida
K. G. Dykstra, Western N. Y. (alt.)
F. J. Erickson, Great Lakes
A. D. Bowers, Philadelphia
A. H. Warth, Maryland
J. C. Ayres, Ames
F. H. Dellwo, Ohio Valley
O. J. Worthington, Oregon (alt.)
J. J. Powers, Dixie

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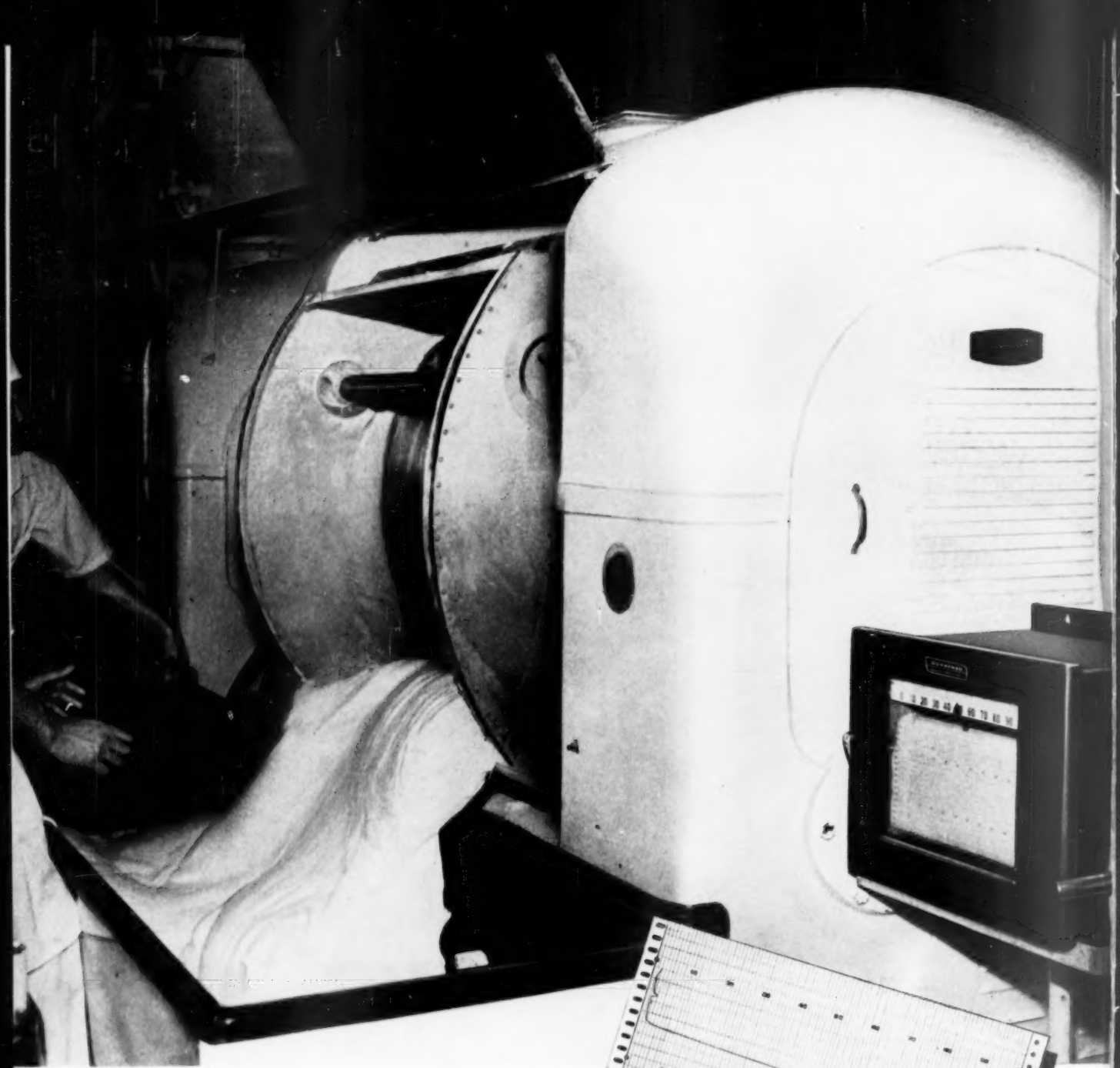

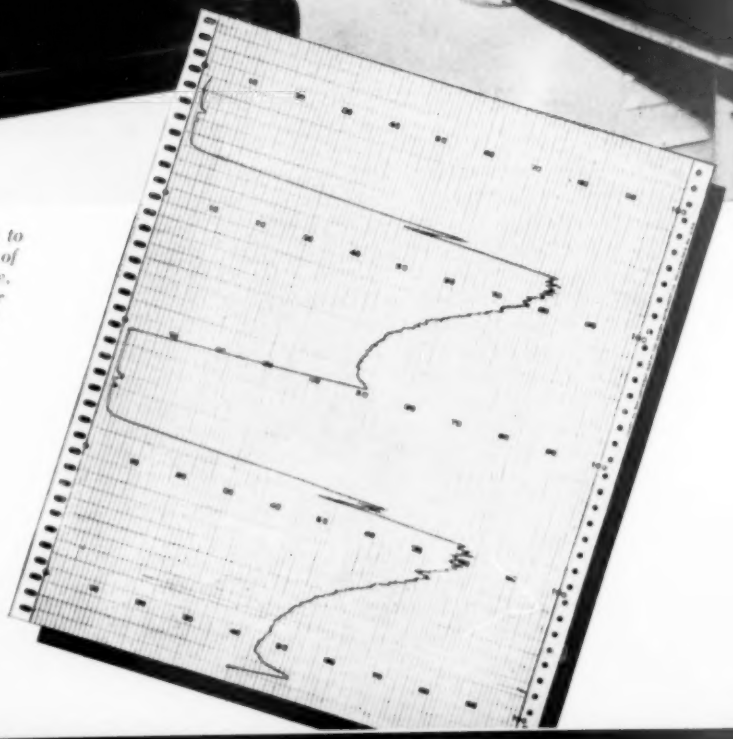

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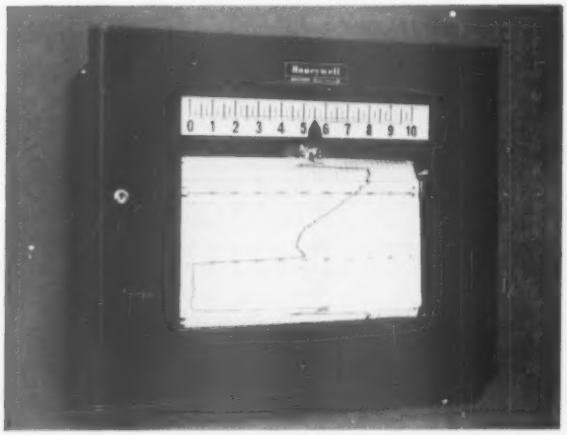

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CONDENSED PROCEEDINGS OF THE MEETING OF THE COUNCIL

(Continued from page 5)

J. H. Gast, Texas (alt.)
N. W. Desrosier, Indiana
D. M. Gray, Pittsburgh

Present, But Not Voting

P. K. Bates, Treasurer
A. N. Prater, Assistant Treasurer
C. S. Lawrence, Executive Secretary
M. S. Peterson, Editor
W. F. Geddes, Guest
F. C. Blanck, Guest

The meeting was called to order at 10:00 A.M. by President Proctor.

1. It was moved, seconded, and carried that:

(a) Responsibility for Annual Meetings of the Institute shall be vested in the Executive Committee of the Council.

(b) The Executive Committee shall have authority to fix the sites of Annual Meetings and determine policies pertaining to the conduct of these meetings.

(c) The Executive Committee may assign responsibilities and authority to carry out these policies.

(d) The responsibilities of the Executive Committee with respect to Annual Meetings becomes effective with the adoption of this resolution.

(e) Any changes in current policy shall not become effective until the 1955 meeting.

(f) The Executive Committee shall accept in general the recommendations made by the current Committee on Annual Meetings and the Council delegates to the President of the Institute authority to resolve any differences of opinion that may arise incident to the interpretation and implementation of these recommendations. This to be completed not later than September 1, 1953.

2. It was moved, seconded, and carried that the President appoint a committee to study the matter of a fixed date for Annual Meetings of the Institute. The report and recommendations of this Committee to be submitted prior to the next semi-annual meeting of the Executive Committee.

3. It was moved, seconded, and carried that effective with the 1955 Annual Meeting of the Institute, fifteen percent (15%), but not to exceed $1,000 of the net proceeds derived from exhibits at Annual Meetings shall be paid into the treasury of the Host Section and the remainder shall be paid into the treasury of the Institute.

4. It was moved, seconded, and carried that $15,000 of the Institute's funds be invested in suitable securities and that the President, Executive Secretary and the Finance Committee determine the securities to be purchased.

5. It was moved, seconded, and carried that the budget as submitted by the Executive Committee for the Fiscal Year 1953-1954 be adopted:

CONDENSED BUDGET

	Projected Receipts	*Projected Expenditures*	*+ Surplus — Deficit*
Food Technology	$59,269.99	$57,218.82	$ + 2,051.17
Food Research	12,065.50	16,245.26	— 4,179.76
National Headquarters	20,911.25	18,776.00	+ 2,135.25

6. The Council, by unanimous vote extends to the Great Lakes Section the appreciation and thanks of the Institute for the very excellent manner in which the 1952 Annual Meeting was conducted which resulted in the realization of the very substantial sum of $9,000 and a $500 Cardex Machine.

7. The Council, by unanimous vote, extends to the Editor of the Journals the Institute's thanks and appreciation for the high standard attained during the past year and requests that the Editor pass on to his Editorial Boards this expression of thanks and appreciation.

8. The Council by a two-thirds (2/3) majority vote directs that the following proposed amendment to Article VII, Sections 1 and 7 of the Constitution be submitted to the membership for vote:

That the Treasurer of the Institute be made a member of the Executive Committee.

9. It was moved, seconded, and carried that Mr. Bernard C. Martin be elected a Professional Member of the Institute.

10. It was moved, seconded, and carried that the question of establishing an annual achievement award for female food technologists be submitted to the Committee on Awards for study and recommendation.

11. It was moved, seconded, and carried that Aksel G. Olsen be appointed Treasurer and Arthur N. Prater re-appointed Assistant Treasurer of the Institute.

12. It was moved, seconded, and carried that the resignation of Aksel G. Olsen as a Councilor-at-Large be accepted effective at the close of the Business Meeting of the Institute on Wednesday, June 24, 1953.

13. It was moved, seconded, and carried that Maynard A. Joslyn be elected a Councilor-at-Large to fill the vacancy created by the resignation of Aksel G. Olsen.

14. It was moved, seconded, and carried that Charles S. Lawrence be re-appointed Executive Secretary and Marian A. Gilchrist be re-appointed Assistant Executive Secretary.

15. It was moved, seconded, and carried that Martin S. Peterson be re-appointed Editor of the Institute Journals.

16. It was moved, seconded, and carried that Roy H. Walters, Oscar B. Williams and Fred H. Dellwo be appointed as members of the Babcock Committee for a period of three (3) years.

17. It was moved, seconded, and carried that the matter of keeping the names of the jurors on Awards Committees secret be referred to the Committee on Awards for study and recommendation.

18. It was moved, seconded, and carried that the amount of the Blanket Position Surety Bond covering

(Continued on page 10)

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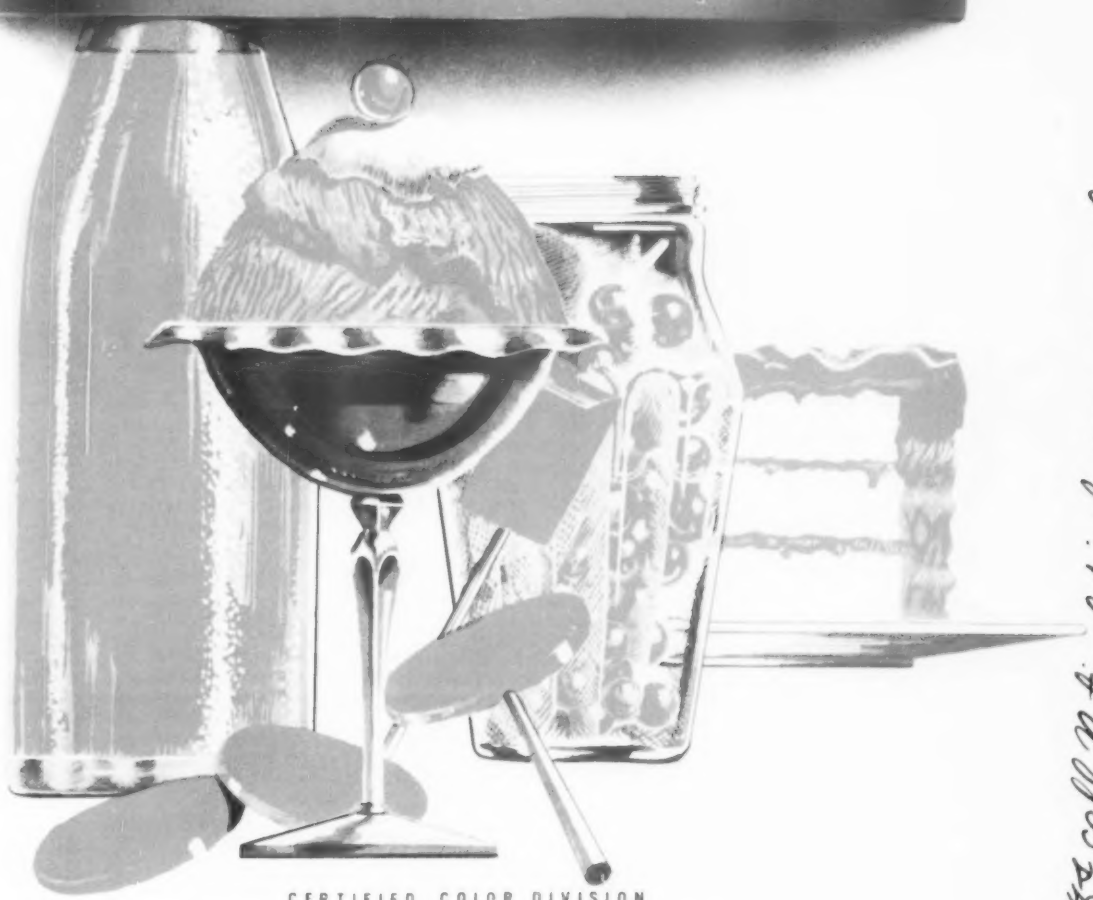

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CONDENSED PROCEEDINGS OF THE MEETING OF THE COUNCIL

(Continued from page 8)

officers and employees of the Institute who have access to Institute funds be increased from $25,000 to $50,000.

19. It was moved, seconded, and carried that those ballots whose validity had been questioned by the Tellers Committee because the voter failed to vote for a candidate for each office be counted as legal votes.

20. It was moved, seconded, and carried that the President, the Executive Secretary and the Assistant Executive Secretary have access to the safe deposit box of the Institute.

21. The Council received the reports of the various committees.

22. It was moved, seconded, and carried that at all future meetings of the Council the reports of committees be first submitted to the Executive Committee for study and recommendation prior to submission to the Council.

23. It was moved, seconded, and carried that the following policy recommended by the Committee on Awards be adopted:

> In harmony with the objective of the Council to develop a procedure which will maintain and enhance the prestige and stature of the Nicholas Appert Award, the presentation pattern followed at Grand Rapids at the 1952 Annual Meeting and proposed for the 1953 Meeting in Boston is approved by the Council as a constructive measure in the fulfillment of this purpose, and should be continued at subsequent meetings. The Council charges the Awards Committee with the responsibility for further study of the Award system to determine any other factors which may be adopted to further the objective of improved presentation procedure.

24. It was moevd, seconded, and carried that the Committee on Publications serve in an advisory capacity to the Council on overall policy and be free to examine and make recommendations on any matters concerning the publication enterprise, including the financial support of the Journals, selection of editors and co-ordination of all publication activities.

25. The Council received a very complete verbal report from Dr. F. C. Blanck, Chairman of the Ad Hoc Committee on Food Standards.

NEW BUSINESS:

26. It was moved, seconded, and carried that the Institute adopt the following policy with respect to H.R. 5055, 83rd Congress:

> "The Institute of Food Technologists endorses the amending of Sections 401 and 701 of the Federal Food, Drug and Cosmetic Act so as to simplify the procedures governing the establishment of food standards.
>
> The Institute wishes to go on record as favoring the principle of simplification of procedures governing the establishment of food standards and the issuance or amendment of food standards, without hearings, in cases in which no protest arises following due public announcement of such proposals and it directs the Executive Secretary to so advise Hon. Charles A. Wolverton, Chairman, House Committee on Interstate and Foreign Commerce."

27. Invitations for the 1956 Annual Meeting were received from the following Sections—Florida, Pittsburgh, St. Louis and Philadelphia. C. M. Harrold, Councilor from the St. Louis Section stated that his section would be willing to be host in either 1956 or 1957. Councilor Brissey of the Chicago Section extended an invitation to the Institute to meet in Chicago in either 1957 or 1958. It was moved, seconded, and carried that these invitations be referred to the Executive Committee for decision.

28. It was moved, seconded, and carried that each retiring President of the Institute be presented with the gavel used during his term of office. This gavel to be suitably engraved, and further, that all Past Presidents of the Institute be presented with similar gavels.

29. The matter of an Institute membership certificate suitable for framing was discussed at length and during the discussion it was pointed out that the Council in 1947 had authorized such a certificate. It was moved, seconded, and carried that the Executive Committee take the necessary action to make these certificates available.

30. There being no further business, the Council adjourned at 3:15 P.M.

Secretary's Annual Report

1. MEMBERSHIP:

Total paid memberships, May 1, 1952		3,386
LOSSES: Deaths and resignations	81	
Dropped for non-payment	248*	329
(* of these, 73 are students)		
BALANCE		3,057
Reinstatements (30) and New Members elected (556)		586
TOTAL PAID MEMBERSHIP, APRIL 30, 1953		3,643
Net Gain for Fiscal Year '52-'53	257	
Net Gain for Fiscal Year '51-'52	178	

CLASSIFICATION OF MEMBERSHIP:

	1952	*1953*	*Plus or Minus*	
Professional Members	2,352	2,505	plus	153
Members	855	958	plus	103
Student Members	179	180	plus	1

2. JOURNAL CIRCULATION:

FOOD TECHNOLOGY:		*Plus or Minus*	
Member Subscriptions	3,643	plus	257
Non-Member Subscriptions	646	plus	83
Advertisers, Exch., Comp. and Editorial	143		
TOTAL	4,432		
Net Gain in paid subscriptions for the year			340

FOOD RESEARCH:			
Member Subscriptions	675	plus	17
*Non-Member Subscriptions	1,162	minus	138
Exchange, Editorial and Comp.	20		
TOTAL	1,857		
Net Loss in paid subscriptions for the year			121

* 41% of non-member subscriptions are Foreign.

The foregoing indicates that comparatively few of our members are interested in FOOD RESEARCH (18.5%) and the drop in Non-Member subscriptions (10.6%) from 1952 indicates a waning interest on the part of Non-Member subscribers.

At the end of 1952, 182 Members dropped their subscriptions to FOOD RESEARCH. However, a considerable number of new

(Continued on page 12)

Doesn't Your Business DESERVE the BEST in Sanitizing Agents?

INSIST ON GENUINE Roccal

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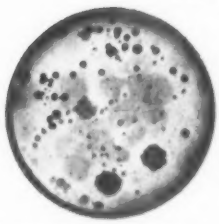
BRAND

SANITIZING AGENT

to do a more effective sanitizing job throughout your plant!

The ORIGINAL Quaternary Ammonium Germicide

Laboratory tested and controlled
2 4 3 1 8 9 R
This Control No. Guarantees
POTENCY
UNIFORMITY
QUALITY



Petri dish showing colonies of bacteria before the use of ROCCAL.

Petri dish showing no bacterial growth after the use of ROCCAL.

In the Food Industry, the importance of using only the best in sanitizing methods cannot be over-emphasized.

In Roccal, the *original* quaternary ammonium germicide, the food industry is offered a sanitizing agent that is laboratory controlled and tested. The uniform quality of Roccal means uniformly good results in doing a proper sanitizing job.

Roccal is a powerful germicide. In recommended dilutions, it is non-poisonous, non-irritating to the skin, virtually odorless and tasteless.

Roccal can be used for every sanitizing job in processing and packaging in the following food industries: milk, cream, ice cream, butter, cheese, egg breaking, sugar, fish, poultry, fresh frozen vegetables and fruits, meat products, cereal products, candy and beverage, wherever the product comes in contact with equipment. Also to keep walls and floors sanitary.

USES IN FOOD INDUSTRY

To Sanitize:

- STORAGE BINS
- FREEZING UNITS
- REFRIGERATORS
- CONVEYORS
- TANKS
- PROCESSING EQUIPMENT
- PACKAGING EQUIPMENT
- AIR CONDITIONING AND COOLING SYSTEMS
- WALLS AND FLOORS
- WASH ROOMS
- TRUCKS
- AND AS A HAND RINSE FOR HELP

Our Technical Service Department stands ready at all times to answer your questions about specific uses for ROCCAL

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you'll find that better sanitation is good business.

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Offices in principal cities throughout the United States

CONDENSED PROCEEDINGS OF THE MEETING OF THE COUNCIL

(Continued from page 10)

members subscribed. This has happened in previous years but most of the new members who do subscribe to the Journal, drop it at the end of the first year.

A part of the decrease in Non-Member subscriptions and increase in Member subscriptions is due to Libraries dropping a Non-Member subscription and having an Institute Member take the Journal for the Library at the member's reduced rate. We receive numerous requests from Librarians to have some Member's copies of FOOD RESEARCH addressed to the Library.

FOOD RESEARCH operated last year at a net loss of $3,564.31. Present indications are that the net loss for the fiscal year 1953-1954 will be as great or greater.

At present costs and subscription rates, it is impossible to make this Journal self-supporting. This matter has been discussed with our Printer, Mr. Garrard, and it is his opinion that the only way by which a journal of this type can survive at present production cost levels is by subsidy or securing Editorial and Administrative services without cost. FOOD RESEARCH was published for fifteen years with Editorial and Administrative services on a "for free" basis and broke even or showed a slight profit.

3. JOURNAL PRODUCTION RECORDS:

FOOD TECHNOLOGY

Month	*Copies Produced*	*Mfg. Cost*	*No. Pages*	*Copies to Stock*
May—'52	4,223	$ 2,764.74	68	144
June	4,368	2,518.26	80	180
July	4,288	2,585.81	68	76
August	4,457	2,756.78	84	217
September	4,388	2,927.40	84	193
October	4,476	2,139.43	64	200
November	4,445	2,560.35	72	121
December	4,403	2,640.00	80	55
Jan.—'53	4,731	2,890.79	80	260
February	4,710	2,862.12	80	216
March	4,515	2,952.57	80	277
April	4,501	2,979.42	80	159
TOTALS	53,505	$32,577.67	920	2,008

Unit Cost (per copy) ..... $ 0.609
Cost Per Page 35.41

Total pages budgeted, 912; total pages produced, 920.

FOOD RESEARCH

Month	*Copies Produced*	*Mfg. Cost*	*No. Pages*	*Copies to Stock*
May-June '52	2,218	$ 1,994.40	128	192
July-Aug.	2,221	1,965.51	108	135
Sept.-Oct.	2,117	1,089.37	64	161
Nov.-Dec.	2,308	2,248.27	128	188
Jan.-Feb. '53	2,380	1,631.62	96	230
Mar.-Apr.	2,100	2,428.93	144	93
TOTALS	13,344	$11,358.10	668	999

Unit Cost (per copy) ..... $ 0.85
Cost Per Page 17.00

Total pages budgeted, 592; total pages produced, 668.

CHARLES S. LAWRENCE,
Executive Secretary

STATEMENT OF AUDITORS

GEORGE V. ROUNTREE & CO.
CERTIFIED PUBLIC ACCOUNTANTS
208 SOUTH LA SALLE STREET
CHICAGO 4

Telephone State 2-0116

May 11, 1953

Institute of Food Technologists, Inc.
176 West Adams Street
Chicago, Illinois

In accordance with instructions received, we have audited the accounts and records of Institute of Food Technologists, Inc. for the year ended April 30, 1953. Statements attached set forth the results of our examination. Our examination was made in accordance with generally accepted auditing standards and accordingly included such tests of accounting records and such other auditing procedures as we considered necessary in the circumstances.

In our opinion, the accompanying Balance Sheet and related Income and Expense Statement present fairly the financial position of Institute of Food Technologists, Inc. at April 30, 1953 and the results of its operations for the year then ended, in conformity with generally accepted accounting principles applied on a basis consistent with that of the preceding year.

GEORGE V. ROUNTREE & CO. (Signed)

INSTITUTE OF FOOD TECHNOLOGISTS, INC.

BALANCE SHEET

April 30, 1953

ASSETS

Current Assets			
Cash in bank:			
General fund	$57,108.15		
Operating fund	3,901.57	$61,009.72	
Account receivable:			
Garrard Press		1,853.38	$62,863.10
Investment			
U. S. Savings Bond Series F due August, 1957			861.00
Inventories			
Back issues of journals:			
Food Technology	7,956.14		
Food Research	2,066.84		
Publication Directory	1,075.08		
Total	11,098.06		
Less: Allowance for depreciation	11,097.06	1.00	
Emblem seals		58.80	59.80

Time to double check VANILLA *Quality*

Many manufacturers today are revising their vanilla flavor formulations, and this is the time to put the stress on quality — make a change for the better. The trend is back to real vanilla taste and the standard Alva vanillas have been doing just this job for years.

In selecting any vanilla, pure or imitation, double check it with the finest pure vanilla extract. Then buy the best you can afford.

With the changing vanilla picture it is important that you check the famous Alva vanillas. There are many to suit your needs, both pure and imitation. The Alva laboratories are eager to help. Send us your problem.

PURE VANILLA EXTRACT
The finest extract, processed for over two months.

PURE VANILLA 4X
Same quality as above, four times stronger.

VANILLA-VANILLIN
The best pure extract extended with vanillin.

IMITATION VANILLA 4X
Developed on a natural vanilla bean base.

IMITATION VANILLA 4X (Special)
An inexpensive grade, excellent for specialties.

IMITATION VANILLA
A clean, brilliant flavor, fine as a chocolate stretcher.

VANILLA SUGAR (Imit.)
A dry imitation bean powder.

VAN AMERINGEN-HAEBLER, Inc.
521 West 57th Street, New York 19, New York

Alva FLAVORS

13

Unexpired Insurance		
		241.16
Furniture and Fixtures		
At cost	2,090.05	
Less: Allowance for depreciation	1,334.38	755.67
Total		64,780.73

LIABILITIES AND CAPITAL

Current Liability		
Monsanto Chemical Company Award		100.00
Deferred Income		
Non-members subscriptions to journals		8,265.33
Capital		
Balance May 1, 1952	41,561.94	
Add: Net income year ended April 30, 1953	14,853.46	
Balance April 30, 1953		56,415.40
Total		64,780.73

INCOME AND EXPENSE STATEMENT

Year Ended April 30, 1953

	Particulars	*Together*	*Institute Operations*	*Food Technology*	*Food Research*
Income					
	Membership dues	$ 27,763.15	$13,881.57	$13,881.58	
	Non-membership subscriptions Food Technology	5,382.36		5,382.36	
	Subscriptions—Food Research	12,001.11			$12,001.11
	Advertising—Food Technology	48,488.44		48,488.44	
	Advertising—Food Research	824.40			824.40
	Proceeds from annual meeting (net)	8,714.02	8,714.02		
	Sales:				
	Back issues of journals	1,170.51		972.91	197.60
	Mailing lists	665.22	665.22		
	Interest earned	26.00	26.00		
	Total	105,035.21	23,286.81	68,725.29	13,023.11
Expense					
	Printing and mailing:				
	Food Technology	33,221.69		33,221.69	
	Food Research	11,027.81			11,027.81
	Advertising commissions:				
	Food Technology	11,137.42		11,137.42	
	Food Research	41.28			41.28
	Circulation expense:				
	Food Technology	708.20		708.20	
	Food Research	832.45			832.45
	Discounts	1,126.53		1,112.18	14.35
	Rent, telephone and telegraph	2,096.42	1,257.85	628.93	209.64
	Stationery, printing and postage	2,500.59	1,500.35	750.18	250.06
	Clerical salaries	6,096.00	3,657.60	1,828.80	609.60
	Secretary's salary	7,466.68	4,480.01	2,240.00	746.67
	General expense	1,142.91	1,142.91		
	Payroll taxes	450.01	270.01	135.00	45.00
	Contingencies—President's office	410.27	410.27		
	Contingencies	589.24	589.24		
	Editor's office:				
	Salaries	5,125.97		3,417.32	1,708.65
	Maintenance	2,325.22		1,550.14	775.08
	Travel	337.50		225.00	112.50
	Contingencies	190.50		127.00	63.50
	Expense—sale of back numbers	282.66		254.29	28.37
	Travel	605.25	363.14	181.58	60.53
	Audit and surety bond insurance	619.34	371.61	185.80	61.93
	Expense—sale of mailing lists	248.89	248.89		
	Depreciation	418.01	418.01		
	Directory's expense	1,180.91	1,180.91		
	Total	90,181.75	15,890.80	57,703.53	16,587.42
Net Income for Year					
	Carried to capital account	14,853.46	7,396.01	11,021.76	−3,564.31

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First to Develop OIL-SOLUBLE Antioxidants .

Now Introducing Monoglyceride* Stabilizers— Both Oil-Soluble and Water-Dispersable!

No Propylene Glycol in these formulas—all are non-reactive with iron. Packed safely in ordinary steel drums. No deposit.

Check these 4 Antioxidants For Choice of Proper Stabilizer For Your Particular Needs

G-4

TYPE C... The original, economical, all-purpose *oil-soluble* antioxidant—for lard and other edible fats and oils sold at retail. Contains Propyl Gallate and Lecithin-Citrate, patented by Griffith. Dissolves by easy stirring.

***New TYPE M...** In this formula Monoglycerides replace Lecithin as the solublizer of Citric Acid. It also contains Propyl Gallate for long stability. *New TYPE M* "G-4" dissolves by easy stirring because, like all Griffith antioxidants, it is fat-soluble and naturally becomes part of the lard. It is water-dispersable, too. (*Patent applied for.*)

G-5... The fat-soluble antioxidant that contains Lecithin-Citrate, and BHA for *high "carry through"* stability in cracker baking. (*Patent applied for.*)

***New G-8...** A variation of the "G-5" formula —with a Monoglyceride-Citrate combination instead of Lecithin-Citrate. Except for its BHA content, "G-8" is the same as *New TYPE M* "G-4" antioxidant, described above. (*Patent applied for.*)

We'll be glad to consult with you and assist in selecting the proper antioxidant for the most practical and profitable stabilization of your products. Tell us your problem.

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Laboratorios Griffith do Brasil, S.A.—Caixa Postal 300 Mogi das Cruzes, Sao Paulo, Brasil

CASH RECEIPTS AND DISBURSEMENTS STATEMENT

Year Ended April 30, 1953

Particulars	*Detail*		*Total*
Cash in Bank			$ 45,914.66
Receipts			
Dues		$27,847.65	
Food Technology:			
Advertising, non-member subscriptions, manuscript subsidies and back numbers		52,663.95	
Food Research:			
Advertising, non-member subscriptions, manuscript subsidies and back numbers		12,412.88	
Mailing lists sold		665.22	
Proceeds from annual meeting		9,000.00	
Cash sales-back issues of journals		37.72	
Sale of IFT seals		5.50	
Monsanto Award		100.00	102,732.92
Total			
Disbursements			
Dues refunded—overpayments and rejections		84.50	
Food Technology:			
Printing and mailing	32,428.81		
Advertising expense	11,137.42		
Circulation expense	313.75	43,879.98	
Food Research:			
Printing and mailing	10,845.31		
Advertising expense	41.28		
Circulation expense	202.68	11,089.27	
Expense—sale of back issues of journals		282.66	
Rent, telephone and telegraph		2,096.42	
Clerical salaries		6,096.00	
Secretary's salary		7,466.68	
Stationery, printing and postage		2,500.59	
Travel		605.25	
Editor's office		7,979.19	
Annual meeting expense		285.98	
Contingencies—President's office		410.27	
Office furniture and equipment		529.77	
Auditing and surety bond		619.34	
Expense—sale of mailing lists		248.89	
Contingencies		589.24	
General expense—National headquarters		1,142.91	
Payroll taxes		450.01	
Directory		1,180.91	
Monsanto Award		100.00	87,637.86
Cash in Bank			
April 30, 1953			61,009.72

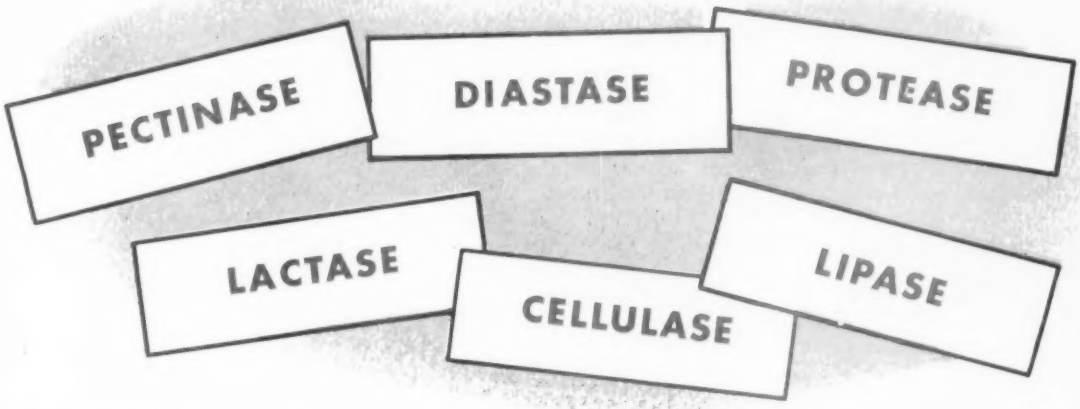
COMPARISON OF ACTUAL RECEIPTS AND DISBURSEMENTS WITH BUDGET

Year Ended April 30, 1953

Particulars	*Actual*	*Budget*	*Actual Over or Under (—) Budget*
Receipts			
Membership dues	$ 27,763.15	$24,500.00	$ 3,263.15
Non-membership subscriptions—Food Technology	5,382.36	4,222.50	1,159.86
Subscriptions—Food Research	12,001.11	12,069.00	—67.89
Advertising—Food Technology	48,488.44	35,689.00	12,799.44
Advertising—Food Research	824.40	799.80	24.60
Income from annual meeting	8,714.02	5,000.00	3,714.02
Sales—back issues of journals	477.79	400.00	77.79
Sales—mailing lists	416.33	150.00	266.33
Sales of IFT seals	5.50		5.50
Monsanto Award	100.00	100.00	
Miscellaneous	26.00		26.00
Total	104,199.10	82,930.30	21,268.80

INDUSTRIAL ENZYMES...

for Faster, More Uniform Processing



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Representatives in principal foreign countries

Disbursements			
Printing and mailing:			
Food Technology	32,428.81	29,731.20	2,697.61
Food Research	10,845.31	9,190.50	1,654.81
Advertising commissions:			
Food Technology	11,137.42	9,822.25	1,315.17
Food Research	41.28	41.22	.06
Circulation expense:			
Food Technology	708.20	671.50	36.70
Food Research	832.45	830.00	2.45
Rent, telephone and telegraph	2,096.42	2,200.00	—103.58
Stationery, printing and postage	2,500.59	2,500.00	.59
Clerical expense	6,096.00	6,600.00	—504.00
Secretary's salary	7,466.68	7,466.67	.01
General expense—National headquarters	1,142.91	1,200.00	—57.09
Payroll taxes	450.01	400.00	50.01
Contingencies—President's office	410.27	750.00	—339.73
Editor's office	7,979.19	8,225.00	—245.81
Office furniture and fixtures	529.77	500.00	29.77
Travel	605.25	1,000.00	—394.75
Contingencies	589.24	1,000.00	—410.76
Auditing and surety bond	619.34	600.00	19.34
Directory	1,180.91	750.00	430.91
Monsanto Award	100.00	100.00	
Total	87,760.05	83,578.34	4,181.71
Excess of Receipts Over Disbursements	16,439.05	—648.04	17,087.09

Regional Section News

MARYLAND SECTION

The May meeting of the Maryland Section of the Institute of Food Technologists was held at the University of Maryland at College Park, on Friday, May 8, 1953. The members of the Section were the guests of the Student Chapter.

The meeting began at 4:00 P. M. with a tour of the Horticulture, Bacteriological, and Dairy Buildings, as well as the U. S. Fish and Wildlife Service Building on the campus. At 7:00 P. M. an excellent dinner, prepared by Mrs. Henry Dorn and her group from the Student Chapter, was served; 71 members and guests were present.

Dr. Edgar P. Walls, who acted as master of ceremonies, introduced the speakers. The first speaker was Dr. Gordon Cairns, Dean of Agriculture, who spoke on the scope and variety of the extension work and services offered by the University. He was followed by Dr. Paul E. Nystrom, Director of Instruction in Agriculture, and Director of the school of Agricultural Economics and Marketing who spoke on the functioning of these schools. The last speaker was Dr. I. C. Haut, Director of the Maryland Agricultural Experiment Station and Director of the Horticulture Department, who spoke on the progress in agricultural research at the University.

The June meeting was held at the Commissary of the Hot Shoppes in Washington, D. C. The manufacturing and preparation facilities of the company were viewed by the members in attendance. Dinner was held at one of the Hot Shoppe Units after which those present were addressed by three members of the staff on Food Preparation, Food Procurement and Records in Cost Accounting.

The respective speakers were: Mrs. Iva Savage, Mr. William Wood and Mr. Howard Johnson.

PERSONNEL

Dr. Lloyd A. Hall, Technical Director, The Griffith Laboratories, Inc., Chicago, Illinois, has been elected Chairman-Elect of the Chicago Chapter, American Institute of Chemists. Dr. Hall is a charter member of the Institute of Food Technologists, has served as a member of the Executive Council, and is presently Councillor at Large. For many years he has been active in the Chicago IFT Chapter and is well known as an outstanding chemist in the food industry.

Books

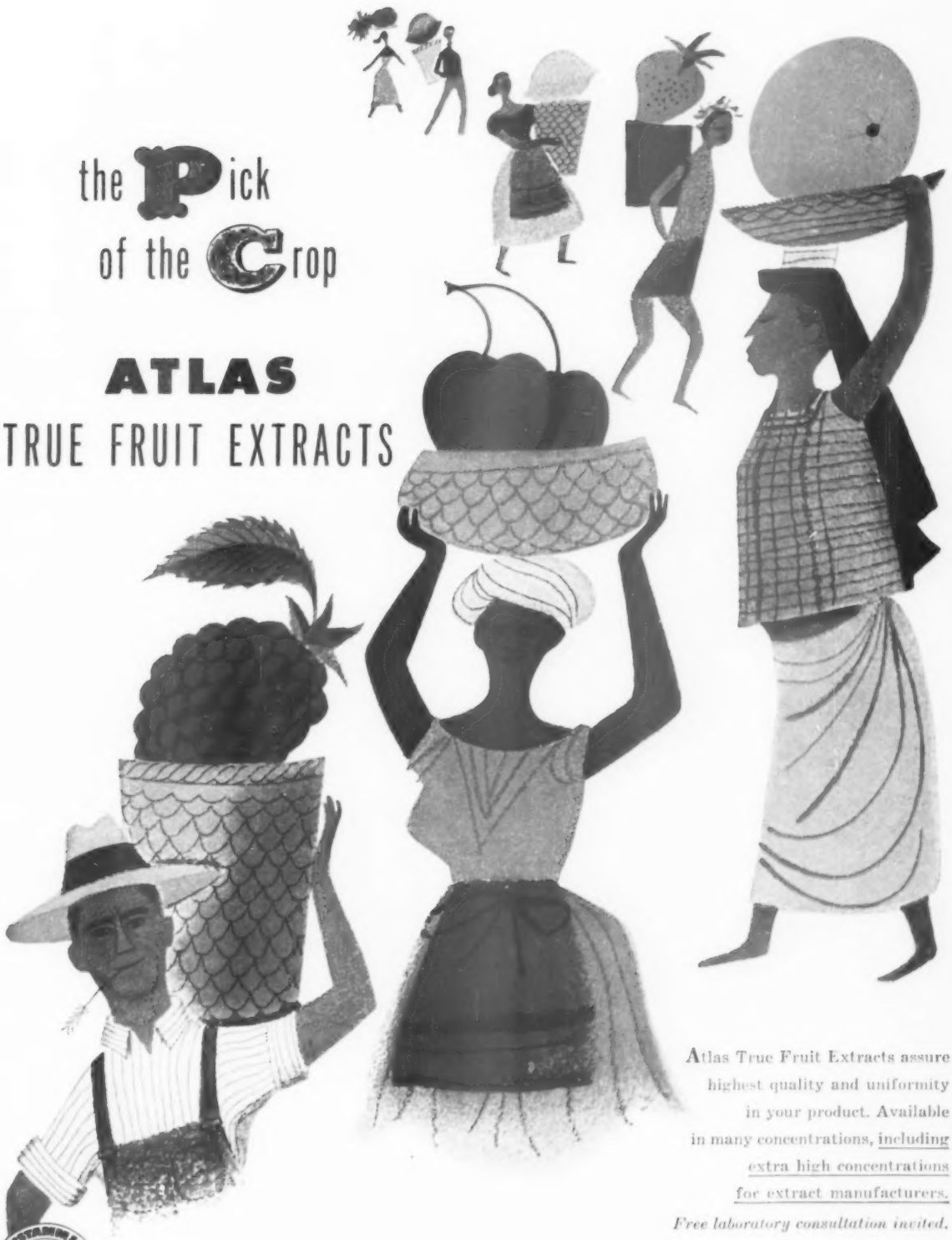
Food and Population and Development of Food Industries In India, Central Food Technological Research Institute, Mysore, India, 1952. 357 pages.

The sharp contrast in food problems in India as compared to the United States is immediately evident in this book. Food technologists are concerned with developing techniques which will make items not previously used as food, palatable and acceptable; with reducing food losses and wastage in surplus areas and seasons; and in helping to expand food production.

The book includes the papers and proceedings of two symposia, one on food and population and the second on the development of the food industries. A large number of Indian public officials and food industry leaders appear to have participated, and the volume provides a picture of their thinking on these issues.

The first symposium shows clearly two points of view on the race between population growth and food pro-

(Continued on page 20)



the Pick of the Crop

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BRANCHES IN OTHER PRINCIPAL CITIES OF THE U.S.A. AND THROUGHOUT THE WORLD

Books

(Continued from page 20)

duction. A number of papers argued that positive checks on population growth were the only alternative to famines, and/or the indignity of food gifts from abroad and a heavy food drain on foreign exchange. Governmental efforts were called for. Another group argued that there were substantial opportunities for increasing agricultural production on existing cultivated areas and through irrigation. Also there were other products which were used for food in earlier and in famine periods which housewives could use and should be using. The government should encourage production and better home utilization.

But regardless of their pessimism or optimism for the 15 to 30 year period all appeared to agree that in the short run food supplies would press hard on population.

The second symposium is a systematic review of the status of food industries in India, beginning with three general papers on a survey, planning and the urgent need for developing the food industry. Papers then discuss food technology with reference to fruits and vegetables, sugar, military needs, flour milling, food yeast, biscuits (British definition), cocoa and chocolates, antioxidants and storage, vanaspati (hydrogenated vegetable oils), fish, glucose from tapioca starch, vegetable oils, refrigeration of perishables, the groundnut (peanut), utilization of minor fruits plus several papers on technical assistance and personnel. Both symposia were followed by short discussions which are also published.

To food technologists this book is of interest in presenting Indian points of view on India's pressing food and population problem, and in the second part in giving information on the current status of the food industry, and beliefs as to future needs and trends in development.

Michigan State College. LAWRENCE WITT

Engineering College Research Council. REVIEW OF CURRENT RESEARCH AND DIRECTORY OF MEMBER INSTITUTIONS, 1953. American Society of Engineering Education. Price $2.50.

This paperbound volume of 330 pages, latest in the series of biennial editions reporting research in all branches of engineering and most related fields provides: 5000 entries of research project subjects—a goodly number in or related to the food field; names of administrative officers; policies governing research projects and contracts; special conferences and short courses; research expenditures; and other information. The data were collected from 103 institutions, the major engineering schools in the United States. The volume should have sufficient reference value for food technologists to justify its being acquired by the technical libraries of food research organizations. It may be obtained from V. E. Neilly, Secretary, Engineering College Research Council, 103 Mechanical Engineering, The Pennsylvania State College, State College, Pennsylvania.

Research and Development Associates, QM Food and Container Institute, Inc. "Stability of Shortenings in Cereal and Baked Products", Series I, No. 2, FOOD STABILITY, QM. FOOD AND CONTAINER INSTITUTE SURVEYS OF PROGRESS ON MILITARY SUBSISTENCE PROBLEMS. Available at cost, $1.00.

The second in the series of SURVEYS OF PROGRESS ON MILITARY SUBSISTENCE PROBLEMS, this 46-page brochure entitled "Stability of Shortenings in Cereal and Baked Products" is comprised of papers presented by members of the staff of the Quartermaster Food and Container Institute, scientists from the U. S. Department of Agriculture's Northern Regional Research Laboratory, and research workers from industry laboratories. Objectives of the January 1953 conference were (a) to review the problem of stability in cereal and baked products with special consideration of the role of shortenings, (b) to discuss current technical advances in the development of antioxidants, transesterification for animal fats, and improvements in the processing of soybean oil, and (c) possibilities of increasing the shortening resources available to the Armed Forces. Papers by Donald K. Tressler, Robert O. Larsen, Junius M. McIntire, H. T. Spannuth, C. E. Morris, A. E. Bailey and J. C. Cowan were presented at the first session, presided over by Reed T. Milner, Director, Northern Regional Research Laboratory. At the second session, William F. Geddes, Chairman, papers by J. Micka, T. E. Hollinshead, and W. H. Goss were read and discussed. Dr. H. R. Kraybill provides a brief foreword for the conference papers. M. S. P.

PASSING OF HARRY McCORMACK ENDS NOTABLE CAREER

Professor Harry McCormack, 76, died June 8. Until his sudden illness, he had been active as Technical Editorial Director of *Food Processing* and *Chemical Processing* magazines, his function being the investigation of technical problems in the food and chemical fields and directing the preparation of information thereon.

He was nationally known to Food Technologists and Chemical Engineers, and for 38 years served as Director of the Chemical Engineering Department of Illinois Institute of Technology and the Armour Research Foundation.

Professor McCormack held degrees from Drake University and the Illinois Institute of Technology. He was an active member of several food and chemical technical societies. Among these were the American Institute of Chemical Engineers, and the Institute of Food Technologists. This March, the American Chemical Society honored him for his fifty years of membership.

Among his many accomplishments over the past fifty years, Professor McCormack was instrumental in setting up the milling and baking standards for flour, which are still used today. As a leader in the concept of a unified science of chemical engineering, he had co-authored the book, "Application of Chemical Engineering."

He is survived by his wife and three sons: Ralph, Robert, and John.

Selected Abstracts*

ANALYTICAL METHODS

Amino acids in cane juice and cane final molasses.

KOWKABANY, G. N., BINKLEY, W. W., AND WOLFROM, M. L. *J. Agr. Food Chem., 1,* 84-7 (1953).

Cane blackstrap molasses contains as much as 50 to 60% simple sugars. Recovery of these sugars in sucrose production is not economical because of the presence of substances formed from reaction of the sugars with amino acids of sugar cane juice. Chromatographic procedures were applied to this juice and its corresponding molasses to identify the responsible amino acids. Two-dimensional, ascending paper chromatography indicates the probable presence of asparagine, aspartic acid, glutamine, glutamic acid, glycine, alanine, valine, leucine (or isoleucine), serine, tyrosine, and γ-aminobutyric acid in Florida cane juice and (except serine, tyrosine, and glutamine) in its corresponding final molasses.

Further studies on the separation of the borate complexes of sugars and related compounds by ion-exchange chromatography.

ZILL, L. P., KHYM, J. H., AND CHENIAE, G. M. *J. Am. Chem. Soc., 75,* 1339-42 (1953).

Further studies were made on the sepn. of sugars and related compds. by the ion-exchange chromatography of their borate complexes on strong-base anion exchangers. Sugars known to occur in complex mixt., such as those obtained from plants, were studied with regard to their elution characteristics. The following compds. were included in this study: raffinose, rhamnose, stachyose, sorbose, gentiobiose, melezitose, melibiose, turanose, sedoheptulose, sedoheptulosan, dulcitol, sorbitol and mannitol. A procedure for the removal of borate from the isolated sugar-borate complexes is presented as part of the process for recovery of the pure sugar.

Identification of flavonoid compounds by filter paper chromatography.

CASTEEL, H. W., AND WENDER, S. H. *Anal. Chem., 25,* 508-9 (1953).

The colors produced by chromogenic sprays when considered in conjunction with the R_f value often aid in the tentative classification of an unidentified flavonoid pigment into one of the major subdivisions of flavonoid compds. The colors produced on paper by chromogenic sprays and certain of the newly studied flavonoids were also detd.

Determination of fluorine in plant materials.

REMMERT, L. F., PARKS, T. D., LAWRENCE, A. M., AND MCBURNEY, E. H. Modifications of the method for detg. fluorine are proposed. A new procedure permits correction of the substantial errors which may be encountered when forage materials contg. large amts. of silica are analyzed.

Direct semimicrodetermination of oxygen in organic substances.

HINKEL, R. D., AND RAYMOND, R. *Anal. Chem., 25,* 470-9 (1953).

An improved app. and procedure were developed to overcome interference due to hydrogen in the Unterzaucher method, to permit accurate analyses of substances of both low and high oxygen content, and to reduce the time required for analysis. Carbon monoxide formed in the pyrolysis is oxidized with iodine pentoxide, the resulting carbon dioxide is absorbed in a measured excess of 0.05 *N* alkali, and the excess is back-titrated with 0.025 *N* acid after pptn. of the carbonate formed with barium chloride. Accurate results are obtained over the range of 0.05 to 50% oxygen, utilizing sample wts. of 15 to 350 mg. and a total analysis time of 35 to 45 min.

Apparatus for measuring gas permeability of sheet materials.

BRUBAKER, D. W., AND KAMMERMEYER, K. *Anal. Chem., 25,* 424-6 (1953).

The operation of the app. is based upon the principle of measuring a change in vol. at conditions of const. pressure and temp. Typical permeability data obtained are included. The significance of the app. and procedure lies in its general applicability and in the fact that results may be obtained rapidly and with a high degree of accuracy.

BIOLOGICAL SCIENCES

BIOCHEMISTRY

Keep liver alive for hours.

Science News Letter, 63, 149 (1953).

Animal livers are now being kept alive outside the body for 6-8 hrs. by mechanically circulated oxygenated blood. As a result, scientists believe they can get important clues to possible diet and gland clauses of artery hardenings, for these test tube livers can continue to make blood plasma components identifiable by radioactive tracer methods. The lipoproteins of the plasmas, now the center of interest in the attack on artery hardening, are made in the liver.

Inhibition of tumor growth by D-glucosamine.

QUASTEL, J. H., AND CANTERO, A. *Nature, 171,* 252-4 (1953).

Expts. were carried out to observe the effects of the administration of D-glucosamine to mice bearing the tumor sarcoma 37. The results indicate that at concns. of D-glucosamine which produce no adverse effects on the normal animal, and which give no signs of shock or toxicity, a marked inhibitive effect on the growth of the tumors takes place. The survival rate of the tumor-bearing animals is practically doubled, while the value for the activity of liver catalase, which is lowered in the presence of tumors, is considerably increased after D-glucosamine administration.

Observations on the fate of ingested cholesterol in man.

BIGGS, M. W., KRITCHEVSKY, D., COLMAN, D., GOFMAN, J. W., JONES, H. B., LINDGREN, F. T., HYDE, G., AND LYON, T. P. *Circulation, 6,* 359-66 (1952); Biol. Abstr., *27,* 551, No. 5868 (1953).

Tritium-labeled cholesterol was used to study several aspects of exogenous cholesterol metabolism in man. The rate and magnitude of the appearance of ingested cholesterol in the various blood compartments was followed. Fecal excretion of the labeling material was measured. Cholesterol of dietary origin was demonstrated in a human atherosclerotic aorta.

Protective effect of adrenal steroid administration on irradiated mice.

MIRAND, E. A., REINHARD, M. C., AND GOLTZ, H. L. *Proc. Soc. Exptl. Biol. Med., 81,* 397-400 (1952).

Mice receiving 500 r head radiation and primed before or after radiation with cortisone or desoxycorticosterone showed evidence that both of these compds. afford protection from the lethal effect of ionizing radiation.

Mobility of skeletal phosphorus in a mature dairy cow as determined with radioactive phosphorus.

BLACK, A. L., KLEIBER, M., SMITH, A. H., AND RALSTON, N. P. *Proc. Soc. Exptl. Biol. Med., 82,* 248-52 (1953).

Radioactive P^{32} was injected intravenously to measure the "labile" phosphorus pool in the skeleton of a mature, lactating dairy cow. Autoradiograms and radio-assays indicated that this labile pool extended throughout the skeleton but its distribution was detd. by the type of bone involved.

Competitive action of isonicotinic acid hydrazide and vitamin B_6 in the formation of indole by E. coli.

YONEDA, M., KATO, N., AND OKAJIMA, M. *Nature, 170,* 803 (1953).

* These Selected Abstracts are made available to FOOD TECHNOLOGY through the cooperation of Associate Editor H. A. Campbell and the General Foods Corporation of New York, N. Y. The abbreviations found in these abstracts are similar to those used by Chemical Abstracts.

Abstracts

Isonicotinic acid hydrazide was shown to act on tryptophanase as an antimetabolite against its coenzyme, pyridoxal phosphate, in *E. coli*. Pyridoxine in large doses caused recovery of growth, indicating competitive inhibition of the coenzyme by the hydrazide.

Stepwise degradation of polypeptides from the carboxyl end.

Boissonnas, R. A. *Nature, 171,* 304 (1953).

The decarboxylation of α-N-acylpolypeptides by anodic degradation on a micro scale is described. This technic could be used to det. the sequence of amino acids in a polypeptide chain.

A chromatographic investigation of the amino acid constituents of normal urine.

Stein, W. H. *J. Biol. Chem., 201,* 45-58 (1953).

Ninhydrin-pos. components of the urine of young adult males were detd. by chromatography on columns of Dowex 50. The quant. values for the types of amino acids capable of detn. are recorded.

Activation of enzymes by chelating agents.

Altmann, S. M., and Crook, E. M. *Nature, 171,* 76-7 (1953).

Evidence is presented to show that the Keilin horse-heart succinoxidase is activated in the presence of histidine, pyrophosphate, 8-OH-quinoline or versene by virtue of their ability to form chelates with heavy metals, thereby removing the metals from the enzyme system. For example, versene counteracted the inhibitory effects of copper and zinc by chelation.

Assay of botulinum A toxin with goldfish.

Cartwright, T. E., and Lauffer, M. A. *Proc. Soc. Exptl. Biol. Med., 81,* 508-11 (1952).

A method was established for the assay of botulinum A toxin in goldfish. When 10 fish were inoculated per diln. and the diln. interval was 10-fold, the end point distribution was found to have a standard deviation of about 0.24 log unit. The end point in fish at 37° has approx. the same value as that in mice.

BOTANY

Occurrence of malonic acid in plants.

Bentley, L. E. *Nature, 170,* 847-8 (1952).

Malonic acid was detected in the leaves of a large variety of plants, the highest concn. being found in the Leguminosae and the Umbelliferae. The acid was isolated and crystd. from the leaves of the runner bean, *Phaseolus coccineus L.*

NUTRITION

Studies to determine the nature of the damage to the nutritive value of some vegetable oils from heat treatment. III. The segregation of toxic and non-toxic material from the esters of heat-polymerized linseed oil by distillation and by urea adduct formation.

Crampton, E. W., Common, R. H., Farmer, F. A., Wells, A. F., and Crawford, D. *J. Nutrition, 49,* 333-46 (1953).

Heat polymerization of alkali-refined linseed oil results in the formation of monomeric acyl radicals whose esters can be distd. at low pressures but which do not form urea adducts. These esters are highly digestible when eaten but are not utilized for growth. The esters contain a small proportion of hydroxyl groups, but are apparently mainly esters of "cyclized" or branched structure. When a fraction consisting essentially of these esters of "cyclized" monomeric acids comprises as much as 10% of the diet, it renders the diet "toxic." The harmful effect is measurable when this fraction comprises 2.5% of the diet. The effect is ascribed tentatively to the "cyclized" monomeric esters as such, rather than to the small proportion of hydroxy acid present in this and other fractions. Dimeric acyl radicals are also formed on heating linseed oil at polymerization temp. A fraction consisting mainly of the esters of the dimeric acids is non-toxic, but this material is largely unabsorbed from the gastro-intestinal tract. Esters of straight chain monomeric acids (i.e., capable of forming urea adducts) are apparently as nutritious as are esters prepd. directly from normal unheated triglyceride oils which, in turn, are but slightly inferior to the triglycerides of normal food.

Cottonseed meals: influence of processing on protein values.

Sure, B., Easterling, L., Dowell, J., and Crudup, M. *J. Agr. Food Chem., 1,* 82-4 (1953).

A biol. study was made of the protein values of three cottonseed meals and one cottonseed flour as influenced by different methods of processing, using the albino rat as the exptl. animal. The protein efficiency of these meals and flour was investigated by the rat growth method at 10, 8, and 5% levels of protein intake. The best product from the standpoint of protein efficiency was the one which was solvent-extd. and had no heat treatment. The cottonseed flour which had the most drastic heat treatment showed the poorest protein efficiency. The biol. value of the proteins in this product was improved by the addn. of lysine and methionine, which had been either partially destroyed or made unavailable during processing.

Enzymatic liberation of amino acids from different proteins.

Denton, A. E., and Elvehjem, C. A. *J. Nutrition, 49,* 221-9 (1953).

It was found that the rate and extent of liberation of amino acids from beef, casein and zein, when measured chemically, were approx. the same, with beef being hydrolyzed slightly more rapidly than the other two proteins. Wide variations occurred in the liberation of amino acids from the proteins when measured microbiologically; however, it again appeared that beef was hydrolyzed slightly more rapidly than the other two proteins. Microbiologically available arginine appeared to be liberated from all proteins studied very rapidly during the pepsin stage of digestion.

Attempts at improving the biological value of wheat protein with lysine or yeast and a comparison with oat protein.

Cremer, H. D., Lang, K., Hubbe, I., and Kulik, U. *Biochem. Zeitschr., 322,* 58-67 (1951); *Biol. Abstr., 27,* 563, No. 5997 (1953).

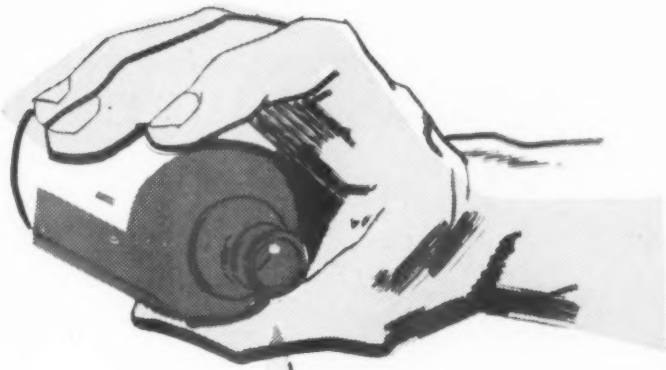
The biol. value of wheat bread (flour 80% milling, 1.8% N) was on the av. 40.5. Baking with an addnl. 0.8 g. DL-lysine increased the biol. value somewhat but adding the lysine in soln. increased the biol. value considerably. Baking the bread with 1-2% dry yeast increased its biol. value only for subjects which showed a low value. Oat flour of the same N content as the wheat flour gave an av. biol. value of 65.5, considerably greater than for the wheat flour.

The influence of various carbohydrates on the utilization of low protein rations by the white rat. I. Comparison of sucrose and cornstarch in 9% casein rations.

Harper, A. E., and Katayama, M. C. *J. Nutrition, 49,* 261-75 (1953).

The influence of sucrose and that of cornstarch on the utilization by the white rat of low casein rations supplemented with methionine were detd. Cornstarch supported better growth of rats receiving 9% casein rations than did sucrose. The growth differences were eliminated by increasing either the level of casein or the levels of 5 essential amino acids in the sucrose ration but were unchanged when liver ext. was included, when the quantities of the B vitamins were increased, or when certain non-essential amino acids were included. The growth of rats fed low casein rations deficient in methionine was also shown to be better when cornstarch was substituted for sucrose as the source of carbohydrate. The growth differences observed are apparently due to the availability of greater quantities of certain essential amino acids when sucrose is replaced by cornstarch. It seems improbable that intestinal microorganisms play a significant role in this regard and it is deemed more likely

(Continued on page 26)



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The Employment of Dioctyl-dimethyl-ammonium-ion as a Sterilizing Agent in Fruit Juice Processing

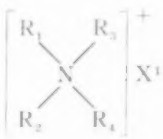
V. T. WALKLEY AND R. D. WILSON

Cantrell & Cochrane Ltd., Hanworth Road, Sunbury-on-Thames, Middlesex

(Manuscript received February 13, 1953)

Sterilization of plant and equipment with the dioctyl-dimethyl-ammonium-ion in aqueous solution has been studied in relation to yeast infection. Modified Chick-Martin tests have been carried out in fruit juices, containing known amounts of dioctyl-dimethyl-ammonium-ion and strains of yeast cells.

Quaternary ammonium compounds are derivatives of the ammonium radical wherein the hydrogen atoms of the latter are completely substituted by organic radicals, the simplest example being a tetramethyl ammonium salt formed by the methylation of ammonia itself, as shown by Hofmann in the middle of the last century. These compounds have the general formula



where R_1, R_2, R_3 and R_4, are organic radicals and X^1 is an anion, e.g. chloride, bromide, sulphate, hydroxide, etc.

Very great variety in physical (and bactericidal) properties is obtained by varying the nature of R, in the above formula, and usually R_1 and R_2 are methyl groups, whilst R_3 and R_4 may be long-chain aliphatic radicals, or even part of a ring-system as in cetyl-pyridium bromide.

Yeast cell spoilage of raw-material and consumer products is of particular incidence in the food industry as a whole, and this is particularly the case in the production of citrus juices, apple-juice and the like. In this respect we have studied the fungicidal properties of the dioctyl-dimethyl-ammonium-ion in aqueous solution. As a test organism 2 yeast cultures were employed, (a) a yeast isolated from (Gloucestershire fruit) apple-juice resembling "Yeast A" of Pearce and Barker *(1)*, and a yeast isolated from a cask of orange juice, Messina, Italy, similar in character to *Saccharomyces cerevisiae* (Hansen). Their characters were as follows:

(a) Yeast "A" (Pearce and Barker): 25° C. in liquid culture apple-juice fermentation rapid and complete in 5 days, no surface growth, cells in wort culture oval, 5-6.5μ × 3.4μ; colonies on beer wort gelatin spherical, dry, surface corragated with fringed indented border; colonies cream coloured both surface and reverse. Streak on gelatin wort agar compact, raised, surface corrugated, dry, edges fringed (25° C.); on apple-juice agar cells ovoid, 5.5μ × 3μ to 6μ × 3μ. Ascospores abundant, 4 per asc and occasionally 2, ascospores 3μ diameter, smooth, single membrane. Ferments sucrose, dextrose, laevulose, maltose, slight turbidity in alcohol, slight growth in nitrate.

(b) Messina Yeast. [*S. cerevisiae* (Hansen)]: 25° C. liquid culture wort a sediment, thin scum and ring, cells round, globose, ranging 3μ to 8μ; ascospores 2 to 4 per asc, ascospores round and smooth; ferments raffinose ⅓; galactose, sucrose, maltose; colonies on wort agar soft, moist, cream coloured, nitrates not utilized, growth on alcohol medium atypical.

EXPERIMENTAL

Sterilization of pipe-lines. Five hundred ml. of unfermented apple-juice, at pH 3.35 and containing approximately 14,000 yeast cells per ml. was poured into an 8-foot section of 1½" i.d. pipe line containing residual organic debris. The pipe-line was rotated to ensure an even distribution of yeast cells. The apple-juice was drained out and the pipe left empty for 24 hours at room temperature (c. 65° F.). At the expiration of 24 hours one end of the pipe-line was closed with a sterile bung and was then filled with a 1:2000 solution of the quaternary ammonium compound (dioctyl-dimethyl-ammonium-ion which will subsequently be referred to as DDAI in this paper). The 1:2000 aqueous solution of DDAI was left in contact with the entire internal surface area of the pipe-line for 24 hours at room temperature. At the termination of this period the DDAI was drained out and the pipe line was cut into 3 sections. Swabs were taken from each section and plate counts made on apple-juice agar plates. The viable yeast cells were then enumerated after suitable incubation.

Replicate experiments were made, and the yeast cell count estimated and averaged. The results are recorded in Table 1.

TABLE 1

Residual yeast cells, enumerated by plate count (at 25° C.) from swabs taken from interior of pipe line containing residual organic debris

Section of pipe line	Average 1. Yeast cells per cm.²	Average 2. Yeast cells per cm.²
A	480	393
B	370	176
C	460	240

The same method was applied to a pipe line in which the internal surface was free from organic debris.

Using similar technique to that described above, the pipe line was filled with apple-juice containing 12,000 yeast cells per ml. drained, filled with DDAI 1:2000 aqueous solution, and later drained and swabs taken for plate count estimation. The results are recorded in Table 2.

TABLE 2

Residual yeast cells, enumerated by plate count (at 25° C.) from swabs taken from interior of pipe line free from organic debris

Section of pipe line	Average 1. Yeast cells per cm.²	Average 2. Yeast cells per cm.²
A	8	nil
B	nil	4
C	3	nil

The organic debris were derived from fruit juice residues which had formed a slight film on the interior surface of the pipe. The great variation in yeast cell population, as a result of

treatment with DDAI on 'dirty' and 'clean' pipe lines, is readily seen by comparison of figures in Table 1 and 2. At a concentration of 1:2000, DDAI reduced the microflora by only 75% in the experiment conducted with 'dirty' pipes containing organic debris, whereas, under similar conditions, but with an initially 'clean' surface, a 99.8% reduction in viable yeast cells was obtained.

DDAI in citrus juices experimentally infected with yeast cells.

Samples of citrus juice were prepared from 30% solutions of orange juice in 12% sucrose solution adjusting the pH to 3.3-3.4. Aliquots of 30% citrus juice so prepared were transferred to sterilized conical flasks and infected with a mixed suspension of yeasts (a) *S. cerevisiae* (Hansen), and (b) the "Yeast A" of Pearce and Barker. Known amounts of DDAI were added, the flasks agitated at intervals, and samples drawn for plate count estimation of the yeast cells at specific periods.

Results of these experiments are recorded in Tables 3, 4, 5, 6, together with the pertinent data.

Reference to Table 3 indicates an extremely high initial concentration of yeast cells, recorded in the 'control' sample as 212,000 yeast cells per ml. This figure is considerably in excess of that normally encountered on plant operation, and subsequent tests, (recorded in Tables 4, 5 and 6) were conducted with a reduced initial yeast cell population.

Employing a technique similar to that adopted for the preparation of Table 3, the levels of the mixed yeast cell population were 920 yeast cells per ml. (Table 4); 37,000 and 113,300 yeast cells per ml. (Table 5); and 32,000 and 18,000 yeast cells per ml. (Table 6).

Time of exposure was reduced to periods of 5 minutes, 15 minutes, and 6 hours, at room-temperature (18° C.), and at the expiration of the specified time samples were taken, suitably diluted in sterile water, and petri dish plate counts prepared using a nutrient-apple-juice agar media. Incubation was carried out at 25° C.

In the case of those plates exhibiting yeast growth (denoted by colony formation) no macroscopical abnormality in colony character was detected, and microscopical examination of the yeast cells showed no gross alteration in essential features.

TABLE 3
Toxicity of DDAI to yeast cells in 30% orange juice

Dilution of DDAI	Period of exposure of test organism at 18° C. pH 3.3.	
	3 hours. Yeasts per ml. remaining viable	24 hours. Yeasts per ml. remaining viable
1:100	0	0
1:1,000	0	0
1:2,000	0	0
1:4,000	0	0
1:5,000	0	0
1:6,000	0	0
1:8,000	26	24
1:10,000	24	202
1:15,000	169	12,370
1:20,000	2,260	9,500
1:25,000	192,000	103,000
1:30,000	168,000	112,000
(Control) none	212,000	—

TABLE 4
Toxicity of DDAI to yeast cells in 30% orange juice

Dilution of DDAI	Period of exposure of test organism at 18° C. pH 3.3			
	3 hours at pH 3.3		24 hours at pH 3.3	
	Yeasts per ml. remaining viable	% yeasts "killed"	Yeasts per ml. remaining viable	% yeasts "killed"
1:5,000	0	100	0	100
1:10,000	8	99.1	0	100
1:20,000	14	98.4	4	99.57
1:25,000	10	98.9	10	98.9
1:30,000	12	98.7	8	99.1
(Control) none	920	0	—	—

TABLE 5
Toxicity of DDAI to yeast cells in 30% orange juice

Dilution of DDAI	Period of exposure of test organism at 18° C. pH 3.4					
	Yeast cells remaining viable enumerated by plate count					
	5 mins.	15 mins.	6 hrs.	5 mins.	15 mins.	6 hrs.
1:100	0	0	0	0	0	0
1:1,000	0	0	0	2,100	120	0
1:5,000	6,200	800	0	8,400	940	0
1:10,000	9,700	650	0	17,600	11,200	0
1:15,000	12,000	11,000	5	28,200	10,700	8
1:20,000	25,000	18,200	14	45,000	34,700	8
1:25,000	24,000	23,100	30	43,000	33,300	60
1:30,000	28,000	24,100	250	46,000	39,000	420
(Control) none	37,000	31,000	51,300	113,300	190,000	130,000

TABLE 6
Toxicity of DDAI to yeast cells in 30% orange juice

Dilution of DDAI	Period of exposure of test organism at 18° C. pH 3.4					
	Yeast cells remaining viable enumerated by plate count					
	5 mins.	15 mins.	6 hrs.	5 mins.	15 mins.	6 hrs.
1:100	0	0	0	0	0	0
1:1,000	12	0	0	80	0	0
1:5,000	120	160	0	80	0	0
1:10,000	8,400	180	6	3,200	420	0
1:15,000	15,000	350	3	10,000	11,700	17
1:20,000	14,000	13,700	40	13,700	14,300	27
1:25,000	41,000	24,300	64	14,000	17,000	380
1:30,000	28,300	22,000	340	16,800	18,000	410
(Control) none	32,000	30,100	33,000	18,200	17,500	22,400

DDAI in imitation mineral water medium. Imitation mineral water was prepared containing sucrose, citric acid, ammonium phosphate, traces of Mg., Ca salt and diluted to contain 3% sucrose with tap water. The pH was adjusted to 3.2, and the liquid filled into sterile 10 oz. bottles, plugged with cotton wool. The mixed yeast culture was prepared and the bottles infected with 10,200 yeast cells per ml. of the mixed yeast culture. Varying concentrations of DDAI in aqueous solution were added, and after specified intervals the viable yeast cells were estimated by plate count methods.

TABLE 7
Toxicity of DDAI to yeast cells in imitation mineral water (pH of bottled product, 3.2)

Dilution of DDAI in bottle	Period of exposure of test organism at 18° C.			
	6 hours		24 hours	
	Viable yeast cells per ml.	% yeasts "killed"	Viable yeast cells per ml.	% yeasts "killed"
1:1,000	0	100	0	100
1:5,000	0	100	0	100
1:10,000	600	94.0	0	100
1:15,000	100	99.0	30	99.7
1:20,000	530	94.7	80	99.2
(Control) nil	10,200	0	46,000	0

Commencing with an initial yeast cell population of 10,200 per ml. reference to Table 7 indicates the reduction in viable cells at intervals of 6 and 24 hours at varying concentrations of DDAI.

SUMMARY

Aqueous solutions of dioctyl-dimethyl-ammonium-ion exhibit relatively high reduction of yeast cell populations in the presence of organic debris, fruit-juice residues and fruit juices. However, it is evident that in situations where the residual organic material takes the form of a surface film, for instance covering the interior surface of pipe lines, reduction in the effective sterilizing power of dioctyl-dimethyl-ammonium-ion occurs.

Employing aqueous solutions of dioctyl-dimethyl-ammonium-ion we have been unable to obtain complete sterilization of yeast cell suspensions at pH 3.2-3.4 in dilutions higher than 1:8000, and the possibility must not be overlooked that toxic adsorption onto the cell wall is a function dependent on the particular phase of the cell development, as much as on the initial concentration of yeast cells present.

Acknowledgment

The authors wish to acknowledge with thanks the permission granted by the Directors of Cantrell & Cochrane Limited, and Cantrell & Cochrane (Fruit Products) Limited, for publication of this paper.

LITERATURE CITED

1. Pearce, E. B., and Barker, B. T. P. The yeast flora of bottled ciders. *J. Agric. Sci.*, 3, 55 (1908).

Laboratory Preparation of Potato Granules by Solvent Extraction

E. G. HEISLER, ANN S. HUNTER, C. F. WOODWARD, J. SICILIANO AND R. H. TREADWAY

Eastern Regional Research Laboratory, Philadelphia 18, Pennsylvania*

(Manuscript received April 14, 1953)

A laboratory method is described for dehydrating mashed potatoes by extraction with organic liquids. The mashed potatoes are suspended three times in the liquid; the aqueous solvent is separated from the potato solids by filtration after each treatment. The final filter cake contains only about 5% moisture and is readily dried by mild heat. Powder prepared by this method is stable, light in color, and is easily reconstituted in water over a wide temperature range to mashed potatoes of good texture and acceptable flavor.

Research and development work on the dehydration of mashed potatoes to powder form (granules) was active in England and in Europe even prior to World War II. The British industry produced about 12 million pounds of granules during the war. Olson and Harrington *(1)* recently reviewed the literature on granules.

Most of the dehydrated potatoes produced in the United States during World War II were blanched and diced or sliced before being dried. This product was suitable for frying or boiling but not for mashing. Production of granules for civilian consumption was started in the U. S. after the close of the war. Demand for dehydrated mashed potatoes is increasing slowly but steadily as more people become aware of the convenience that the preparation offers. Since the outbreak of fighting in Korea, interest in potato granules has increased greatly because the product has proved successful in feeding troops. Four American manufacturers are now engaged in production, and research on the subject has been stimulated.

GENERAL METHODS OF PRODUCING GRANULES

The general methods employed in producing granules consist in cooking the potatoes, mashing them to break the bonds orienting the potato cells, reducing the moisture content to a point at which the tissue can be granulated, and finally drying to 7-10% moisture content. In commercial practice, moisture content is reduced to about 35% by mixing previously dried granules with the fresh mash. Other methods of reducing the moisture content have been proposed or used commercially to a limited extent. These include partial drying, in which heat is employed under mild conditions and severe mechanical stress is avoided, and the so-called "freeze and thaw" method. In the latter process, certain changes occur during the freezing so that juice is liberated during the thawing.

METHODS OF DEHYDRATING MASHED POTATOES BY SOLVENTS

We are unaware of any previous method of dehydrating mashed potatoes by extracting the water with an organic liquid. When mashed potatoes are stirred into a water-miscible organic liquid, the solvent evidently enters the cells, where it mixes with the juice. After the liquid phase has equilibrated, the aqueous solvent is removed. The treatment is repeated until the potato cells have a low residual moisture content, after which they are dried with mild heat. Figure 1 shows photomicrographs of cells

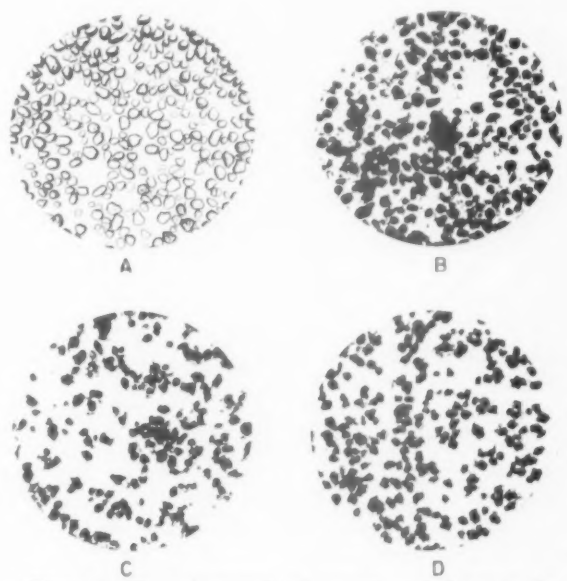


Figure 1. Photomicrographs of cooked, mashed potato tissue; magnification 12 ×: Cells mounted in (a) water; (b) 50% ethanol; (c) 70% ethanol; (d) 95% ethanol.

in cooked potato tissue before and after dehydration to various degree by ethyl alcohol. The effect of alcohol on gelatinized starch is to change it from a transparent paste into a white, opaque solid. As the photomicrographs show, the interior of

* One of the laboratories of the Bureau of Agricultural and Industrial Chemistry, Agricultural Research Administration, United States Department of Agriculture.

the potato cell becomes opaque. Although the reduction in particle size is not pronounced, some shrinkage accompanies alcoholic dehydration. Some broken cells can be seen in B, C, and D of Figure 1. Ruptured cells must be kept at a minimum because the presence of appreciable "free" starch in mashed potatoes leads to pastiness.

An organic solvent such as alcohol firms potato cells. It also provides a medium to keep the cells separated until dehydration is advanced and stickiness gone. In its ideal form, the final product consists essentially of discrete potato cells with a minimum of agglomerates. This is an important attribute of the solvent method, because the granulation step, designed to reduce moist mashed potato powder to substantially unicellular form, is one of the most difficult in the production of granules by thermal dehydration.

Several methods, including vacuum filtration and centrifugation, have been employed in separating the aqueous solvent from the potato solids.

Continuous liquid extraction and vapor-phase extraction of mashed potato tissue were explored briefly and abandoned for various reasons. Passage of the liquid solvent through a vertical column is slow, particularly in the early stage of dehydration. Vapor-phase dehydration was unsuccessful because the vaporized organic liquid tended to pass through in channels.

The following procedure has been found convenient in the laboratory for dehydrating potatoes by solvent extraction. The potatoes are generally not peeled unless the raw material has an unusually tough, heavy skin. The skin is screened off along with the coarse material after the product is dried to a powder. Clean potatoes are sliced into strips about ¼" thick and steamed for 35 minutes. The potatoes are then mashed by beating for 2 minutes at high speed in a Hobart Mixer (Model N-50),[b] with the flat beater attachment. The organic solvent is added while the beater moves at slow speed. The slurry is filtered after 15 minutes of mixing. The filter cake is broken up and resuspended in fresh solvent if more than one extractive step is to be employed.

A number of water-miscible solvents were evaluated. The more promising ones were tried at different ratios of solvent: potato to compare their effectiveness in removing water and to obtain information on the amount of solids removed. Data on 5 solvents are summarized in Table 1. These are results of a single extraction; a maximum of 2 parts by weight of solvent to 1 of wet mashed potatoes was used. Not enough water is removed under such conditions to permit drying the product to a powder.

The amount of dissolved solids increased in each case as the proportion of water to organic solvent was increased; i.e., with decreasing ratio of solvent to potato. Since the suspensions were centrifuged after mixing and standing, data on the extracted solids actually show amounts of solubles separated in the liquid phase from the settled layer. The settled layer became less compact and contained more liquid when less organic solvent was present.

The combination of sugars, inorganic salts, organic acids, and nitrogen compounds—those compounds in uncooked potato that are soluble in water—ordinarily constitute about 20% of the total solids. It will be noted in Table 1 that the amount of dissolved solids exceeded 20% in some instances where the concentration of solvent was low. Dissolved starch contributed to these unusually high values. The presence of soluble starch in the centrifugate was proved by the iodine test.

Several factors are involved in arriving at the preferred solvent or solvents. Acetone removes water efficiently while extracting relatively little of the potato solids. It distills in anhydrous form (advantageous for re-use of the solvent) at a low boiling point. However, acetone imparts disagreeable flavor and odor to the product. Attempts are being made to correct this. Methanol is reasonably good in water extraction and distills in anhydrous form. Ethanol is relatively good as an extractive solvent, particularly at the intermediate concentrations shown in Table 1, and yields a final product of good flavor. The 5% water present in distilled ethanol limits its dehydrating value. Isopropanol and tertiary butanol were given little consideration, because their azeotropes contain considerable water.

[b] Mention of brand or trade names in this paper does not imply that the article is recommended or endorsed by the U. S. Department of Agriculture over similar articles not mentioned.

TABLE 1

One-step extraction of mashed potatoes with different solvents at various ratios

Part anhyd. solvent/part potato [c, d]	Water extracted, % of total	Parts water extracted/ part solvent [c]	Solids dissolved, % of total	Solids extracted, % of total
Methanol				
2	82.3	0.32	14.7	12.2
1.5	81.9	0.43	15.1	12.3
1	74.3	0.58	16.0	11.9
0.5	65.7	1.04	18.2	12.0
0.25	41.9	1.32	18.3	7.7
Acetone				
2	86.7	0.35	10.9	9.3
1.5	83.7	0.45	11.1	9.4
1	76.7	0.61	13.1	10.1
0.5	73.8	1.18	16.8	12.6
0.25	49.5	1.57	21.4	10.5
Ethanol				
2	81.2	0.33	16.8	13.6
1.5	79.2	0.42	18.3	14.5
1	77.6	0.62	19.8	15.4
0.5	71.4	1.14	23.9	17.5
0.25	24.9	0.80	33.8	8.4
Isopropanol				
2	79.5	0.33	11.3	9.3
1.5	83.1	0.44	12.1	10.1
1	80.5	0.64	12.9	10.4
0.5	68.2	1.10	17.4	12.0
0.25	29.9	0.95	24.2	7.2
Tertiary Butanol				
2	84.0	0.34	11.9	10.0
1.5	80.0	0.43	12.9	10.2
1	76.4	0.61	14.9	11.4
0.5	60.2	0.96	22.7	13.8
0.25	49.5	1.58	28.7	14.2

[c] By weight.

[d] Solvent concentrations in liquid phase of solvent-potato mixtures are as follows for the various ratios of solvent to potato: ratio of 2 parts solvent to 1 of potato, 71.7%; 1.5 to 1, 65.5%; 1 to 1, 55.8%; 0.5 to 1, 38.8%; 0.25 to 1, 24.1%.

Single vs. several extractions. A comparison was made to determine the relative efficiency and possible effect on texture and flavor of several extractions of the mashed potatoes.

A better yield of fine particles (Table 2), dependent largely on the concentration of organic liquid in contact with the potato solids before the final filtration, was obtained with multiple extractions. Not only a higher yield of fine powder was obtained, but less solvent was needed. A large percentage of fine material is necessary to give a product that reconstitutes to a smooth, lump-free mash.

TABLE 2

Effect of number of extractions on granulating efficiency. (Extraction of 1000 g. of mashed potatoes)

Solvent,[e] grams/treatment			Solvent in filtrate, %	Yield of dry granules, % of total yield	
1st	2d	3d		—30 mesh	—80 mesh
Ethanol					
3000	[f]	[f]	71	60	50
2000	1000	[f]	88[g]	93	82
Methanol					
2000	[f]	[f]	70	54	18
1000	500	[f]	83[g]	75	55
Ethanol					
1500	1000	[f]	85[g]	88	70
500	400	300	84[g]	86	78

[e] Ethanol, 95%; methanol, anhydrous.

[f] No treatment.

[g] Final filtrate, before drying.

Three-step procedure for extraction. As indicated by the data in Table 2, a 3-step extraction offers considerably more economy in solvent requirement than a 2-step or single extraction. Hence a similar procedure has been tentatively adopted as our standard laboratory method. The first extraction is carried out with the aqueous solvent obtained by combining the second and third filtrates of the previous batch. (At the beginning, before filtrates are available from previous batches, the first extraction is made with 500 g. of distilled solvent, which was 95% in the case of ethanol and anhydrous with acetone and methanol). The second and third extractions are made with fresh solvent distilled from the filtrate of the first extraction.

One thousand grams of mashed potatoes are suspended in organic solvent in accordance with the directions previously given. The suspension is filtered through Schleicher and Schull Co. "Shark Skin" paper on a 24-cm. diameter Buchner funnel with suction. The acetone suspension filters the most rapidly, and the ethanol suspension the most slowly. The filtration rate of the methanol suspension is intermediate. The filter cake is broken up and suspended in 400 g. of fresh solvent. After being mixed for about 15 minutes, the suspension is again filtered on a Buchner funnel. This filter cake is suspended in 300 g. of fresh solvent, again mixed, and filtered. The final filter cake (containing only about 5% moisture) is broken up by gentle agitation and dried to about 7% moisture content by application of mild heat.

Table 3 gives data on the 3-step extraction with acetone. The figures represent average, typical values obtained after 10 or more cycles of granule preparation.

TABLE 3

Dehydration of mashed potatoes by 3-step acetone extraction. [1000 g. potatoes (19.6% total solids)]

	First suspension	Second suspension	Third suspension
Wt. of acetone, g.	830[b] (82%)	400 (anhyd.)	300 (anhyd.)
	First filtrate	Second filtrate	Third filtrate
Wt. of filtrate, g.	1400[c]	530	300
Wt. dissolved solids in filtrate, g.	25	[d]	—
Composition filtrate, %[e]			
Acetone	42	76	90
Water	58	24	10
Composition filter cake, %			
Potato solids	37	51	54
Acetone	26	37	41
Water	37	12	5
Wt. filter cake, g.	467	338	316

[b] Combination of second and third filtrates of preceding cycle.
[c] Filtrate goes to still for recovery of anhydrous solvent.
[d] Dissolved solids determined only in first filtrate, which contains more than 95% of total solubles extracted.
[e] Liquid constituents only, not including dissolved solids.

For every 1000 g. of mashed potatoes dehydrated, 700 g. of recovered solvent are used, and approximately 1400 g. of aqueous solvent are made available for redistillation. As shown in Table 3, the 1400 g. of 42% acetone will yield 588 g. of anhydrous solvent, and nearly 130 g. additional are available in the final filter cake.

About 50% of the water-soluble potato solids (approximately 10% of the total solids) are removed in solvent dehydration. These solubles can be recovered by distilling off the water, under reduced pressure, from the solution remaining after recovery of the organic solvent. When the solution becomes sirupy, containing about 50% solids, evaporation of water is stopped, and the sirup is mixed with an equal weight of dry granules to prepare a free-flowing flavor concentrate that mixes readily with mashed potato powder.

Nature of the extracted solubles. The mixture of substances extracted from cooked potatoes by aqueous organic solvents is a brown material, waxy when water-free. No complete analaysis has been made of this mixture. An aqueous alcoholic solution obtained by a 2-step extraction of Maine Green Mountain potatoes contained 5.6% nitrogen (35% nitrogen compounds calculated by the 6.25 conversion factor) and inorganic substances equivalent to 20.0% ash, on the dry basis. Undoubtedly, products of the reaction between amino compounds and reducing sugars were present, and presumably sugars, organic acids, minor constituents, and some fat.

COMPARISON OF PROPERTIES OF SOLVENT- AND THERMAL-DEHYDRATED POTATOES

Density. The density (apparent) of mashed potato powder produced by the solvent method ("solvent granules") is lower than that of the commercial, thermal-dehydrated product ("thermal granules"). Powder density varies with the solvent used. With the 3 solvents most commonly used, density decreased with decreasing boiling point. Thus in comparative experiments, ethanol boiling at 78.4° C. produced granules having a density of 0.78; methanol boiling at 64.7° C. gave a density of 0.73; and acetone boiling at 56.5° C. produced a density of 0.67. Thermal granules typically have a density of about 0.85.

Water absorption. Solvent granules can be reconstituted in water ranging from cold to near boiling. Thermal granules, however, absorb little water below about 140° F. and require 160-180° for best results. All granules tend to give a pasty product when reconstituted in boiling water.

Color. Solvent granules are nearly white. Some yellow color is imparted by putting back extracted solubles, but the product is still lighter than thermal granules.

Flavor. Solvent granules reconstitute to a mash of bland flavor when considerably less than the normal amount of potato solubles is present. Replacement of solubles can give a reconstituted product similar in flavor to fresh mash. When solvent granules are dried with more than the usual amount of heat treatment, the product more closely resembles thermal granules in flavor.

Storage properties. Comparative storage tests on solvent and thermal granules are in progress. Solvent granules apparently need no sulfite treatment to prevent deterioration of flavor and color in storage. Sulfiting of thermal granules, though, has been a common practice in the industry.

Yield of product. From 1000 parts of potatoes (20% total solids), a yield of 176-178 parts of granules at 7% moisture is obtained by dehydration with ethanol or acetone without "add back" of solubles. Twenty-five to 30 parts of potato solubles remain in the spent filtrate, which is distilled to recover solvent. Hence, mechanical losses are slight in laboratory practice. Typically, 86-88% of the granules pass through a 30-mesh screen and 76-78% through an 80-mesh screen. The material retained on a 30-mesh screen consists largely of small bits of skin and skin lumped with potato tissue.

COMPOSITION OF SOLVENT GRANULES

Composition of granules prepared by a given process depends on the nature of the solvent and the character of the raw material. Potatoes representing 3 varieties were extracted with various solvents. Variety had a pronounced effect. For example, in extraction with alcohol only 15% of the total nitrogen was removed from Florida Sebago, 35% from the Maine Green Mountain variety, and 38% from North Carolina Cobbler potatoes. Different amounts of fat, sugars, inorganic substances, and organic acids were extracted from different varieties of potatoes by the same solvent. The different solvents produced appreciably different nitrogen retention in the same variety. There was relatively high nitrogen retention when acetone and ethanol were used. Acetone extracted less of the sugars and inorganic substances than ethanol and much less than methanol. Table 4 shows the results with the Florida

TABLE 4

Changes in composition produced by solvent extraction of mashed potatoes (Florida Sebago)

Constituent, % [1]	In raw material	Granules prepared by use of		
		Ethanol	Methanol	Acetone
Total N	1.48	1.26	1.05	1.31
Crude fat	0.66	0.33	0.39	0.41
Total sugars	1.98	0.69	0.46	1.27
Starch	73.4	78.1	82.6	77.5
Ash	5.71	2.36	1.73	2.46

[1] Moisture-free basis.

Sebago variety. Results obtained with the Green Mountain and North Carolina Cobbler varieties were similar to those with the Florida Sebago.

FLAVOR OF SOLVENT GRANULES AND ITS RELATION TO THE AMOUNTS OF SOLUBLES AND RESIDUAL SOLVENT PRESENT

Tasters in this laboratory have repeatedly compared fresh mashed potatoes with reconstituted, commercial thermal granules and with experimentally produced solvent granules. No reconstituted dehydrated product is generally considered equal to the fresh mashed potatoes. Preference concerning thermal and solvent granules is largely a matter of individual opinion. Prominent factors in forming an opinion are preferences with regard to bland vs. pronounced potato flavor and white vs. slightly yellow color.

Because they have their original content of flavorful solubles, thermal granules have more potato flavor than solvent preparations. In addition, thermal granules have a flavor quality presumably imparted by the heat treatment. The sulfite content of commercial thermal granules is apparently too low to be objectionable to most persons.

Tasters were in almost unanimous agreement that "add back" of solubles improves the flavor of solvent granules. Beyond 80% of the original solubles content, however, they could detect no further improvement as the flavorful substances were increased to their full complement.

Dehydrated mashed potatoes retain a small amount of organic liquid that is held rather tenaciously during drying. It is doubtful if as much as 0.5 to 1% of acetone or alcohol in the dry powder is detectable by taste after reconstitution. Obviously, though, the residual solvent must be reduced to virtually zero in a food product. Indications are that drying to about 7% moisture followed by remoistening to 10-12% will remove the adsorbed solvent. As an example, samples of granules containing 2.2% methanol and 1.6% acetone were subjected to light steaming for 35 minutes and then redried to 7% moisture content. After this, the former had 0.09% methanol and the latter 0.01% acetone content.

A more direct method is being sought for removing adsorbed solvent during drying. Slow drying at relatively low temperature is promising in this regard. The data in Table 5 show how reduction of the drying temperature resulted in pronounced lowering of the residual ethanol content. There are indications that residual solvent content can be reduced still more by letting the mashed potatoes cool to room temperature before suspending them in the solvent, instead of using warm potatoes, which was our usual procedure. This is certainly true with ethanol. Residual alcohol in the final product can be reduced one-third to one-half by letting the mash stand for 4 hours at room temperature before starting the extraction.

TABLE 5

Effect of drying temperature on residual content of ethanol in granules (2 hrs. in tray drier)

Temperature, ° F.	Final moisture content, %	Residual ethanol in granules, % [m]
92	11.6	0.6
108	7.6	0.8
130	7.1	0.9
150	5.9	1.1
170	3.3	1.2
190	2.1	1.1

[m] Moisture-free basis.

Engineering studies under way at this laboratory are designed to aid in selecting equipment and to determine procedures for larger scale production. One major objective is to devise methods for handling the slurries and drying the final filter cake under conditions that will minimize loss of solvent. Another objective is to provide a cost estimate for production of solvent granules.

SUMMARY AND CONCLUSIONS

Laboratory studies have shown that granules of good color, texture, and acceptable flavor can be prepared by extracting the water from potatoes with certain organic liquids. Of the solvents tried, ethanol, methanol, and acetone gave the best results. Acetone extracted the least amount of water solubles, but granules prepared by alcohol extraction were superior in flavor.

A 3-step laboratory procedure, each step consisting of suspending mashed potatoes in the solvent and filtering off the liquid phase, has been employed. Equilibrium conditions are established after several cycles. The combination of filtrates from the second and third treatments of the preceding cycle is used for the first extraction of wet mash. Hence, the solvent is used twice before recovery by distillation. Distilled solvent recovered from spent aqueous filtrate, plus fresh solvent to replace that lost in drying the final cake, is used for the second and third extractions. In commercial manufacture of granules, however, solvent from the filter cake would necessarily be recovered. Because of the promise indicated in this preliminary work, laboratory studies on solvent granules are being continued.

Acknowledgment

The authors wish to acknowledge the assistance of R. T. Whittenberger of this laboratory, who prepared the photomicrographs.

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Application of Enzymes to Corn Syrup Production[a]

D. P. LANGLOIS
A. E. Staley Manufacturing Company

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Combinations of enzyme and acid hydrolysis of starch produce starch syrups having particular characteristics different from those produced by one hydrolyzing agent alone. Three new products of starch are a result of this study—a 63 D. E. syrup of high sweetness and non-crystallizing; a 55 D. E. syrup of high body and fairly high sweetness, also non-crystallizing; and a 90 D. E. palatable, solid sugar.

The first major disclosure as to the nature of starch came with the discovery by Kirchhoff *(8)* in 1811 that starch in acid solution produced a sweet sugar-like material. The nature of the reaction was apparently not at first understood because the early investigators such as Schrader *(15)* and Vogel *(16)* believed that the conversion was effected by the acid withdrawing the elements of water from starch. It remained for Saussure *(14)* to demonstrate clearly that the reaction was one of hydrolysis and the starch sugar was identical with grape sugar. From such meager knowledge of the structure of starch—simply that it was sensitive to acid hydrolysis and thereby produced a sugar—the corn syrup, or more accurately the starch syrup, industry developed. As early as 1814 *(2)* a factory for producing syrup from potato starch was built.

Starch is now known to be composed of dextrose units linked together by hemiacetal linkages. About 95% of these linkages are from the 1 position of one dextrose unit to the 4 position of the adjacent dextrose unit. The other 5% of the linkages are between the 1 and 6 positions of adjacent dextrose units and form branches in the starch molecule.

These hemiacetal linkages, sensitive to acids, are readily hydrolyzed in acid solution. Since 95% of the linkages are equivalent, the acid has no specificity for the large majority of the linkages and the acid hydrolysis becomes a random one. The ensuing products are dextrose and dextrose polymers of various degrees of polymerization. It is therefore evident that for any degree of hydrolysis of starch with acids, as measured by copper reducing value for example, there is only one composition which will occur. The amounts of dextrose, maltose, trisaccharide, tetrasaccharide etc., will always be the same for a hydrolysis product of any given dextrose equivalent. Figure 1, a graph prepared by Moyer and Cantor *(6)*, shows the composition of acid hydrolysis products over the range of 25% to 60% hydrolysis as measured by dextrose equivalent (copper-reducing value calculated as dextrose on a dry substance basis).

For simplicity the hydrolysis products are divided into only 4 divisions: dextrose, a monosaccharide; maltose, a disaccharide; higher sugars which include the tri- and tetrasaccharides; and dextrins which include all polymers higher than tetrasaccharides. From this graph it is found that at 42 D. E. (dextrose equivalent) the syrup has the composition 22% dextrose, 20% maltose, 20% higher sugars and 38% dextrins. It is evident then that during acid hydrolysis of starch it is not possible to vary at will more than one of the 4 above mentioned constituents. The other 3 are fixed by the degree to which the one is produced. This imposes a severe limitation on the manufacturer of syrups for special uses where the specific qualities of more than one of the constituents becomes an important or desired feature.

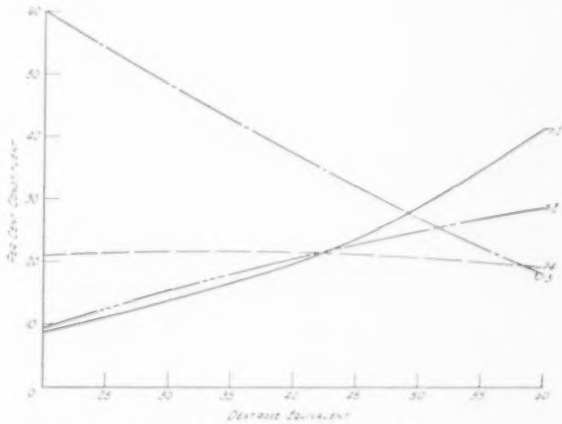

Figure 1. Acid hydrolyzed corn syrup analysis. 1, dextrose; 2, maltose; 3, dextrins; 4, higher sugars.

Another important advance in starch hydrolysis came with the discovery of the starch splitting diastase of malt and with the commercial development of this enzyme. This diastase has the property of inducing hydrolysis of the hemiacetal linkages of starch. The enzyme differs from acid in that it has a certain specificity, for particular linkages, and hence these are hydrolyzed preferentially. Maltose and dextrin appear as the main products of hydrolysis with small amounts of higher sugars and dextrose occurring in the latter stages of reaction. The dextrins are of a different character from those obtained by acid hydrolysis, since a conditioned hydrolysis instead of a random hydrolysis occurs. Analysis of syrups prepared by the hydrolysis of starch with malt diastase shows them to be strikingly different from acid hydrolyzed syrups. The hydrolysis pattern is expressed in Figure 2. In this study only 3 constituents—maltose, higher sugars, and dextrin—were separated using the chromatographic technique of McDonald and Perry *(10)*. Since the conversion was discontinued as soon as it had reached about 80% maltose equivalent, dextrose was present in only trace

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amounts. Had the reaction been allowed to continue longer considerable dextrose would have been formed as has been found by other investigators.

BACKGROUND

Use of malt diastase in the preparation of malt syrup was the first application of enzymes to corn syrup production. With this tool it is possible to make syrups of quite different composition from those prepared by acid hydrolysis. A wide variety is possible depending on the degree of hydrolysis obtained. Only one, however, has had any great commercial success. That is the high conversion syrup of about 85% maltose equivalent.

During the past 25 years the field of enzyme research has expanded tremendously and nowhere more profitably than in the carbohydrate research. Several excellent reviews *(1, 5, 11, 12, 13)* have recently appeared on the subject of carbohydrates and their relation to the structure of starch.

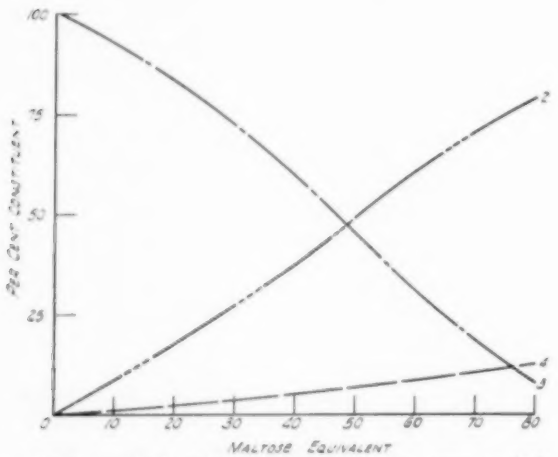

Figure 2. Malt hydrolyzed converted corn syrup analysis. 2, maltose; 3, dextrins; 4, higher sugars.

There are at least 3 recognized amylases of considerable importance. Two, alpha and beta amylase, have been recognized and characterized for quite some time. The third, only recently definitely characterized, has been variously called maltase, dextrinase, gamma amylase, glucamylase, and amyloglucosidase. The latter term suggested by Cori and Larner *(3)* and by Kerr *(7)* is probably the most descriptive.

Alpha amylase has the property of breaking the 1,4 linkages of starch indiscriminately so that in the early stages of reaction only reducing dextrins are formed. After hydrolysis has proceeded to about 25% maltose equivalent maltose appears and increases with continued conversion while the dextrins decrease. Dextrose and higher sugars are also formed in the latter stages of the reaction.

Beta amylase acts only on the non-reducing end of the starch chains and splits off maltose stepwise down the chain. Only maltose and the unreacted portion of the starch molecule are present at any time. The reaction is complete at about 50% conversion to maltose.

Amyloglucosidase attacks the starch at the non-reducing end of the chain and splits off the dextrose units stepwise down the chain hydrolyzing the 1,4 linkages. It is able to by-pass the 1,6 linkages so that all 1,4 linkages are ultimately hydrolyzed and 95% hydrolysis of starch to dextrose is easily possible.

Judicious use of these enzymes either singly or in combination could lead to an almost unlimited variation in the products of hydrolysis of starch. Syrups of any desired properties could thus be prepared. Commercial production of these enzymes provided the corn syrup manufacturers with the solution to their problem of controlled hydrolysis of starch. They were no longer bound by the limitations of acid hydrolysis. Consider only a few of the characteristics significant to the users of corn syrups such as: palatability, sweetening power, reducing power, humectant character, viscosity, fermentability, osmotic pressure, and freezing point lowering. All are functions of the relative amounts of the 4 above-mentioned constituents present in the syrup. To get the proper balance of these characteristics to do a particular job the manufacturer should have free control of all 4 constituents. Enzymes furnish this control.

CONTROLLED PROPERTIES IN CORN SYRUP

The idea of using a combination of acid and fungal enzymes for producing a controlled hydrolysis of starch, to yield a product having particular properties, was expressed by Dale and Langlois *(4)* in 1940. That idea has been expanded further and a commercial acid-enzyme converted syrup, Sweetose, is on the market. Properties desired in this particular syrup were: high sweetness and non-crystallization of dextrose. This result was achieved by choosing an acid-converted syrup of certain characteristics and superimposing upon it an enzyme conversion using a fungal enzyme of the type of Hydralase (Jacques Wolff), Rhozyme S (Rohm and Haas), Mylase (Wallerstein), or Dextrinase (Takamine). The extent of each conversion was determined from a study of the hydrolysis pattern of the starch under the influence of each catalyst.

ANALYTICAL ASPECTS OF ACID ENZYME CONVERSION

Figure 3 shows the dextrose (D)—dextrose equivalent (D.E.) relation existing in corn syrups of varying degrees of conversion. The line marked "A" is the relation for acid converted syrups. The 3 branching lines give the relation for syrups converted with acid to the indicated D.E. and thereafter converted with enzymes. The target represents the limit aimed at to obtain maximum dextrose and therefore maximum sweetness, without getting a crystallization of dextrose. Two of the conversions, lines 1 and 2, were made with Hydralase. The third—No. 3—was made with Rhozyme S. The former enzyme produces less dextrose for any D.E. which indicates that its amyloglucosidase to alpha amylase ratio is lower. Because of the different ratios of these enzymes in different commercial products it is not always possible to reach the target. If the amyloglucosidase is too low a 65% D.E. or 40% D. may be impossible to obtain. If it is too high, a dextrose content of 42% may be obtained at 60% D.E. or even less. In actual

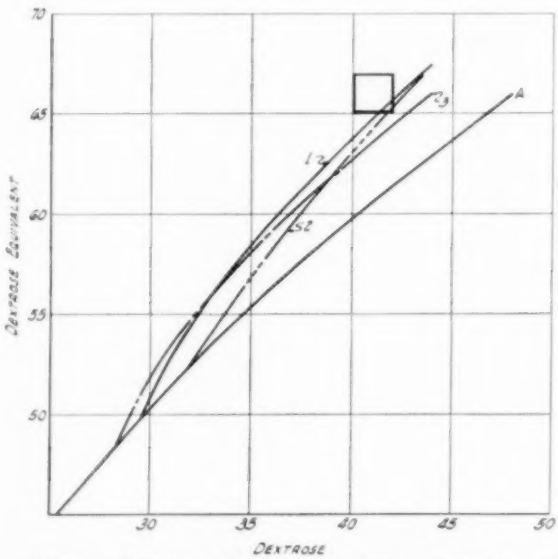

Figure 3. Relation of dextrose to dextrose equivalent in acid and enzyme hydrolyzed corn syrup. A, acid hydrolyzed syrup; 1, Hydralase hydrolysis of a 49.5 D.E. corn syrup; 2, Hydralase hydrolysis of a 52.3 D.E. corn syrup; 3, Rhozyme hydrolysis of a 48.4 D.E. corn syrup.

practice products having analyses anywhere in the vicinity of the target are considered quite satisfactory.

Differences in pattern of the hydrolysis of acid and enzyme conversions are clearly shown in Figure 4. A vertical line is

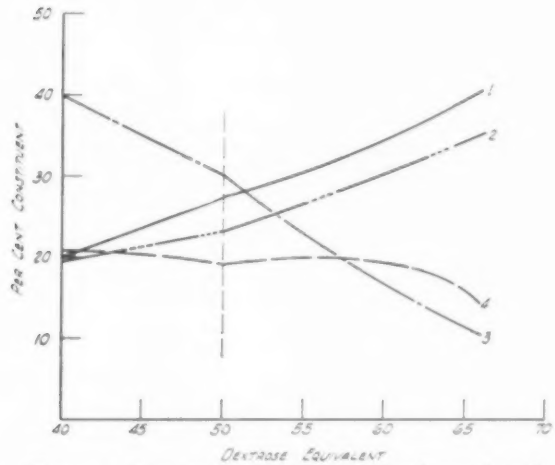

Figure 4. Sweetose (acid-enzyme hydrolyzed syrup) analysis. 1, dextrose; 2, maltose; 3, dextrins; 4, higher sugars.

drawn at 50 D. E. which is the starting point for enzyme hydrolysis. The portion of the graph to the left of the line is identical with the similar portion of Figure 1. The portion to the right is the composition-dextrose equivalent relation produced by enzyme conversion. The 2 patterns, Figure 1 and Figure 4, are distinctly different. For any given D. E. the enzyme converted syrup shows a lower dextrose content, a greater maltose and higher sugar content and a lower dextrin content. The particular pattern obtained here is due to the action of alpha amylase and amyloglucosidase in the enzyme mixture. The former produces maltose and the latter dextrose from the dextrins. The higher sugars are end products of the reaction.

METHOD OF PREPARATION

A typical example of an acid-enzyme conversion which would produce a syrup of the desired character is as follows: a starch slurry of about 20° Be. is acidified to 1.8 pH and converted under 30 to 40 pounds steam pressure to approximately 50 D. E. The converted material is adjusted to 4.8 pH, clarified and evaporated to 50% dry substance. This substrate is transferred to tanks where it is adjusted to about 5.5 pH and 55° C. A solution of fungal enzyme of the type mentioned is added to the extent of about 0.05% of the D. S. syrup and the conversion continued for about 48 hours until the desired D. E. is obtained. It is not necessary to have any exact D. E. of acid conversion since the final D. E. can be controlled by the time of enzyme conversion or the amount of enzyme added. Table 1 gives the amount of enzyme required for any given starting D. E. to obtain the given final D. E. in 48 hours. Table 2 gives the time required to obtain the desired conversion from a syrup of any given starting D. E. using 0.025% enzyme (D. S. basis). The proximate analysis of the syrup is given in Table 3.

TABLE 1

Enzyme requirements for different starting D.E.'s

Starting D.E.	Percent enzyme required (D.S. basis) to reach	
	65% D.E.	63% D.E.
45	0.051	0.044
46	0.048	0.041
47	0.044	0.038
48	0.041	0.034
49	0.038	0.031
50	0.034	0.028
51	0.031	0.025
52	0.028	0.022
53	0.025	0.019
54	0.022	
55	0.019	

TABLE 2

Time requirements using 0.025% enzyme

Starting D.E.	Hours to reach final D.E. using 0.025% enzyme	
	Final D.E. 65	Finel D.E. 63
45	98	84
46	92	79
47	84	73
48	79	66
49	73	60
50	66	54
51	60	48
52	54	42
53	48	36
54	42	
55	36	

TABLE 3

Sweetose analysis [b]

	%
Dextrose equivalent	63
Dextrose	37.5
Maltose	34.2
Higher sugars	16.1
Dextrin	12.2

[b] All analyses on a D.S. basis. To obtain values on a commercial 43° Be. basis multiply by .82.

A product similar to this acid-enzyme converted syrup but not identical with it has been prepared by the action of malt on an acid converted syrup. The same conditions of conversion were used except that fungal enzyme was replaced by 3% malt. The results are indicated in Figure 5. Line A represents the D. E./D. relation of acid converted syrup, line E represents that of the fungal enzyme converted syrups starting with an acid converted substrate of 48.4 D. E. and lines 1, 2 and 3 are the relation for malt converted syrups using 3 substrates of the indicated D. E.'s.

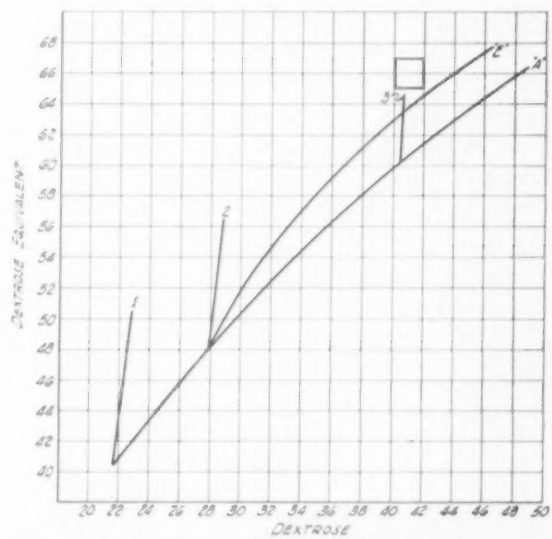

Figure 5. Dextrose to dextrose equivalent ratio of corn syrup. A, acid converted syrup; E, Rhozyme hydrolysis of a 48.4 D.E. corn syrup; 1, malt hydrolysis of a 40.5 D.E. corn syrup; 2, malt hydrolysis of a 48.4 D.E. corn syrup; 3, malt hydrolysis of a 60.5 D.E. corn syrup.

Only one of the 3 conversions approaches the target set for the desired product. This conversion is different from the fungal enzyme conversion in that very little dextrose is produced by the malt hydrolysis although considerable increase in D.E. occurs. This indicates that chiefly maltose and higher sugars are being produced at the expense of the dextrins. Little dextrose is formed. As can be seen here also, a wide variety of syrups are possible depending on the D.E.of the acid converted substrate and the extent of malt conversion.

Recently a syrup has been prepared in response to a demand for a non-crystallizing, high-fermentable product. To prevent crystallization at 43° Be., which is the usual concentration of commercial corn syrup, the dextrose must be kept below 42% (dry substance basis). An enzyme low in amyloglucosidase must therefore be used. To obtain the high fermentability alpha amylase must be used. An acceptable syrup was prepared by several enzymes and enzyme combinations. The results are given in Table 4. Conditions of conversion were the same as

TABLE 4

High fermentable syrups [a]

Kind of enzyme	Amt. of enzyme	D.E. of substrate	After enzyme conversion [d]			
			D.E.	D.	F.E.	F.E./D.E.
1. Colase	0.025%	49	59.4	27.5	69.2	1.16
2. Colase	0.1%	26	50.5	12.5	69.4	1.37
3. Hydralase	0.1%	21	56.1	28.0	65.8	1.17
4. { Colase	0.025% }					
{ Hydralase	0.025% }	49	64.2	34.0	71.6	1.12
5. { Colase	0.025% }					
{ Am [e]	1 unit/g. }	49	66.9	42.2	69.5	1.04

[a] All analysis on a D.S. basis.

[d] D.E. = Dextrose Equivalent.
D = % Dextrose.
F.E. = Fermentable Extract.

[e] Am = amyloglucosidase.

those described above. The Colase is a purified malt enzyme.[f] The amyloglucosidase was prepared in our laboratory. One unit of amyloglucosidase will convert 0.1 g. of starch to completion in 48 hours at 55° C.

DISCUSSION

All syrups listed in the table meet the requirements mentioned. The differences between them lie in the ratio of dextrose to other fermentable sugars. Therefore, they differ as to sweetness, viscosity, osmotic pressure and humectant character. The one actually marketed was No. 3 but the final choice as to which syrup to manufacture will depend on the cost and the significance of these latter-named characteristics.

Another application of enzymes to starch hydrolysis is described in a recent patent *(9)*. The product in this case is not a syrup, however. Starch is exhaustively hydrolyzed and a product is obtained which is about 90% dextrose. When cast in molds, the hydrolyzate sets up to a solid cake. Advantage of the product is that it is palatable without further purification. Corn sugars of this degree of conversion prepared by acid hydrolysis are not palatable because of bitter reversion products. Acceptance of the acid-enzyme converted syrup was immediate and its introduction marked the beginning of a great expansion in the use of corn sweeteners in food fields. Not merely a substitute for sucrose, it is a sweetener having desirable characteristics in its own right. These characteristics are due to the balance of the aforementionel constituents, viz. dextrose, maltose, higher sugars, and dextrins.

[f] Supplied by the Columbia Malting Company, Chicago.

As corn syrup expands into the industrial fields it will be possible for the manufacturer to supply desirable variations from the present products merely by making use of the available enzymes and enzyme systems. The 4 constituents of corn syrup and the characteristics contributed by them to the syrup can be varied almost without limit.

SUMMARY

Acid hydrolysis of starch is a random action and the composition of the resulting syrup is a function only of the degree of conversion. Enzyme hydrolysis of starch is a patterned action and the composition of the resulting syrup is a function both of the degree of hydrolysis and the kind of enzyme used. The 3 recognized diastatic enzymes—alpha amylase, beta amylase and amyloglucosidase—show distinctly different patterns of hydrolysis. One or more of these enzymes may be used in conjunction with acid in the hydrolysis of starch to produce syrups of very specific composition and having definite physical and chemical characteristics.

Three products have been produced commercially. One is converted to about 63 D. E. and has high sweetening power with no crystallizing tendency. Another is converted to about 55 D. E. and has moderate sweetness and high fermentability. A third is converted to over 90 D. E. and has a degree of sweetness almost equal to pure dextrose. It is palatable without further purification and crystallizes to a solid mass.

In the preparation of new starch hydrolysis products for specific uses there is practically no limit to the combination of properties which can be obtained by using these techniques.

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Thermodestruction of Staphylococcus Enterotoxin Experimentally Inoculated Into Fresh Pork

G. M. DACK, M.D. and MICHAEL J. SURGALLA, Ph.D.
Food Research Institute, the University of Chicago[*]

(Manuscript received April 30, 1953)

Precise information concerning the amount of heat necessary for inactivation of *Staphylococcus enterotoxin* is lacking because no good method is available for measuring enterotoxin. The most sensitive method is feeding human volunteers and the next best method is feeding monkeys, although the latter require much greater doses. For example, foods containing a sufficient quantity of *Staphylococcus enterotoxin* to cause severe food poisoning symptoms in man are without effect on monkeys.

Early work utilizing human volunteers established that enterotoxin in veal infusion broth cultures can withstand boiling temperature for 30 minutes *(2, 3)*, although some destruction appeared to have taken place. Reactions of monkeys fed heated enterotoxin indicated a progressive destruction by heat *(4, 7)*. Other experiments *(1)*, with partially purified enterotoxin yielded after boiling no positive reactions in monkeys. If this apparent disparity is real rather than a reflection of the different assay methods, it may be that veal infusion broth contains substances which shield the enterotoxin.

An experiment was conducted recently to ascertain whether enterotoxin in a particular meat product would be inactivated by cooking in a specified manner. Since human volunteers were fed the cooked product, and because they are such sensitive indicators, it is felt that it is important to record this experiment.

PROCEDURES

One liter of a 48-hour culture of a potent enterotoxin producing staphylococcus strain was produced in Amigen medium in Roux bottles according to previously described methods *(6)*. The potency of the strain chosen had been established in numerous prior experiments in one of which a monkey died after a feeding test. Whole culture containing liberal amounts of enterotoxin was used for inoculation of 4 fresh pork shoulder roasts (Boston butts).[*] Using a 2½ inch, 20-gauge needle attached to a 50 ml. syringe, the culture was infiltrated throughout the tissue of each of the 4 roasts to such a degree that the flesh became distended and liquid oozed from the tissue. The external surfaces of the meat were smeared with the culture.

The meat was then held for *2* hours at 98° F. (36.7° C.) overnight at 40° F. (44.4° C.), and for *2* additional hours at 98° F. Following this period of storage a slice was taken from each of the 4 roasts. A 4-pound, 8-ounce butt and a 6-pound butt were cooked first. The other butts were held at 40° F. and cooked the following day.

The meat was cooked in preheated lard for *2* hours, 40 minutes, in a Nesco Electric Roaster. Sufficient lard was used in the cooker so that when the meat was added the lard rose approximately level with the top of the butts. During cooking the boiling and bubbling of the lard caused it to spread over the meat. The cooker remained covered throughout the process, and the thermo regulator on the roaster was set at 500° F. (260° C.) for the entire cooking period.

Two thermocouples were inserted into each butt—one outside of the blade bone and one inside of the bone—to establish the internal temperatures in the deepest or thickest portion of the meat. The temperatures were determined by means of a potentiometer attached to the thermocouples. The internal and external temperatures are given in Table 1 for the first cook.

TABLE 1
Cooking temperatures of inoculated Boston-cut butts

Time minutes	4 lb., 8 oz. Butt No. 1		6 lb. Butt No. 2		Fat temp.
	1	2	1	2	
	°F.	°F.	°F.	°F.	°F.
0	55	58	56	57	360
10	57	59	57	58	369
20	67	73	59	64	348
30	104	104	78	75	336
40	176[b]	134	106	88	329
50	214	159	153[b]	103	323
60	262	183	191	119	322
70	290	194	207	134	327
80	302	207	220	147	329
Butts were turned after 80 minutes					
90	310	211	265	167	325
100	319	212	311	188	330
110	329	213	325	204	341
120	340	213	333	210	356
130	352	214	346	213	367
140	362	216	355	213	378
150	376	220	373	216	392
160	388	224	382	218	402

[b] Thermocouple exposed to hot fat due to splitting of the meat.

Immediately following cooking the roasts were removed from the fat and additional internal temperatures were taken with an Illinois Testing Laboratory Company type 4200 pyrometer with a stab head. The head was thrust into the thickest portion of each roast. Temperatures are given in Table *2*.

The discrepancy in temperature can be attributed to the cooking away of the meat from the bone which exposed thermocouple junctions to the fat.

Essentially the same procedure was followed with the *2* remaining roasts. The thermocouple positions were changed

[*] In cooperation with members of the Research Division of Armour & Company.

TABLE 2
Internal temperatures after cook

4 lb.,8 oz. Butt No. 1	6 lb. Butt No. 2
°F.	°F.
214	207
212	209
210	212
211	208
208	208

TABLE 3
Cooking temperatures of inoculated Boston-cut butts

Time minutes	4 lb., 8 oz. Butt No. 3		6 lb. Butt No. 4		Fat temp.
	1	2	1	2	
	°F.	°F.	°F.	°F.	°F.
0	45	45	46	46	500
10	46	46	48	53	371
20	52	50	59	73	359
30	63	59	72	95	345
40	80	78	92	123*	342
50	103	112	116	156	342
60	128	150	140	187	343
70	148	174	160	205	344
80	162	185	179	220	343
Turned after 80 minutes					
90	176	192	203	270	340
100	190	202	212	327	345
110	198	207	212	329	353
120	205	209	212	338	363
130	209	212	212	350	374
140	211	212	213	345	380
150	212	214	215	356	402
160	212	216	218	367	411

* Thermocouple exposed to hot fat.

slightly in an effort to obtain a more representative internal temperature. The temperature data is given in Table 3.

The 4 slices of meat (136 g.) which had been taken before cooking from the inoculated fresh pork were ground in a Waring Blendor with 136 ml. of water. Two agar plates containing 7% sheep's blood were streaked with the centrifuged meat, after removal of the supernatant liquid, and were incubated at 37° C. The colonies on both plates after 24 hours were predominantly staphylococci with colony appearance and hemolytic properties characteristic of the inoculated enterotoxigenic strain. A few non-hemolytic colonies were present. All of 10 different colonies picked at 24 hours were staphylococci as indicated by the Gram stain technique.

ASSAY TESTS ON MACACCA MULATTA

Varying doses of the original culture supernate were fed monkeys. Feedings of 1 and 5 ml. had no effect. A dose of 25 ml. caused a monkey to become ill.

Two monkeys were fed 50 ml. doses of supernate from heated (490-505° F. for 30 minutes) whole culture. No symptoms of illness developed.

TABLE 4
Summary of monkey feeding tests

Material fed	Dose	No positive/ No negative
Original S-6 culture supernate	1 ml.	0/2
Original S-6 culture supernate	5 ml.	0/2
Original S-6 culture supernate	25 ml.	1/1
Heated Whole Culture (490-505° F. for 30 minutes)	50 ml.	0/2

TESTS ON HUMAN VOLUNTEERS

After the cooking described above, slices were taken from each of the first 2 butts cooked in such a manner that samples representative of the entire roast could be obtained. Two-ounce samples were eaten along with bread, butter, pickles, ice cream and coffee by 2 volunteers. The balance of the meat was stored overnight at 40° F. and the following morning 9 volunteers ate 2-ounce portions of the cold cooked inoculated pork roast. The meat was so apportioned that each volunteer ate a sample representative of the whole roast. The 11 volunteers ranged in age from 25 to 51 years. All volunteers were under observation for a 5-hour period and no significant change occurred in their temperature, pulse or blood pressure. No symptoms of staphylococcus food poisoning were reported during such period or thereafter.

DISCUSSION

The experiment here reported was designed to answer the question of whether *Staphylococcus enterotoxin* experimentally inoculated into raw pork roasts could survive specified cooking conditions.

Since the culture of staphylococcus used produces the most potent enterotoxin of any strain tested, it was thought that for the purpose of this experiment it would be unnecessary to feed the raw unheated culture to human volunteers.

As has already been stated, monkeys are much more resistant to *Staphylococcus enterotoxin* than man. Man has been made ill with as little as 1 ml. of enterotoxic culture whereas doses as high as 25 to 40 ml. were required to cause illness when fed to monkeys *(5)*. The potency of the enterotoxin in the inoculum used here is apparent when it is observed that 25 ml. caused a monkey to vomit. It is, also, not without significance that twice this dosage of whole culture (50 ml.), fed to 2 monkeys, was without effect after heating for 30 minutes in a sealed metal container immersed in lard at 490-505° F.

The tissue of the fresh meat was liberally infiltrated with a culture of viable staphylococci. The 2 two-hour incubation periods at 98° F. were included in the experiment to provide further opportunity for the staphylococci to grow and elaborate more enterotoxin. The two-oz. samples of cooked pork eaten by the human volunteers should have contained quantities of enterotoxin considerably in excess of the amount needed to cause a consumer to suffer the symptoms of staphylococcus food poisoning.

It must be concluded that *Staphylococcus enterotoxin* experimentally introduced into fresh pork roasts was inactivated under the given time and temperature conditions.

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New Procedures for Evaluating Thermal Processes for Foods in Cylindrical Containers

C. R. STUMBO
State College of Washington, Pullman, Washington

(Manuscript received January 31, 1953)

This paper presents the development of new and reasonably simple procedures for evaluating thermal processes for foods in cylindrical containers. The equations presented to implement application of the procedures to actual processing problems are designed to integrate heat effects throughout the container. The procedures are based on the hypothesis that in order to evaluate the capacity of a heat process to reduce the number of bacteria in a container of food, consideration must be given to heat treatments received by all points throughout the container rather than that received by any one point.

Sample calculations are presented demonstrating application of the equations in the solution of some common process evaluation problems, and possibilities for improvement of thermally processed foods through application of the procedures presented are discussed.

In 1948 certain bacteriological considerations relating to the evaluation of thermal processes for foods were presented *(10)* for the purpose of demonstrating that in process evaluation procedures greater attention should be given to the order of death of bacteria when subjected to moist heat and to the mechanism of heat transfer within the food container during process. This presentation was followed in 1949 by another *(11)* in which was described a graphical procedure for estimating the effectiveness of thermal processes in terms of their capacities to reduce the number of viable bacteria in containers of food for which the heating characteristics were known. Development of the procedure was based on a number of rather rough approximations which were pointed out in the presentation. In addition, the procedure is tedious and time-consuming in application to the extent of greatly limiting its practical value.

In 1951, Hicks *(6)* presented a procedure for evaluating thermal processes which was based on essentially the same principles regarding bacterial destruction and mechanism of heat transfer as was the procedure referred to above *(11)*. Gillespy *(5)* in 1951 also presented a procedure, for evaluating processes for conduction-heating foods, which was based on these same principles. As pointed out by Hicks *(7)* in a comparison of the procedures, all 3 were designed to accomplish the same objective, though the algebra employed in their development differed. Also, as he demonstrated in his comparison, the 3 procedures give essentially the same results in application. The procedures described by Hicks and Gillespy are essentially mathematical in operation, each employing different tables of parameters. The tables of parameters for either are also different from those developed by Ball *(2, 3)* for evaluating the severity of heating at the geometrical center of a container of food during process.

The purpose of this paper is to present mathematical procedures which are relatively simple in operation; which employ only tables of parameters presented by Ball *(3)*, and familiar to all involved in evaluation of processes for foods; and which are based on more nearly correct approximations than was the graphical procedure presented earlier *(11)*.

DEVELOPMENT OF PROCEDURES AND DEMONSTRATION OF THEIR APPLICATION

Basic Assumptions. In the development to be described, certain basic assumptions were made. They are as follows:

a. The order of death of bacterial spores subjected to moist heat is logarithmic. Evidence in support of this assumption has been reviewed by a number of authors *(5, 6, 9, 10)* and shall not be considered further here.

b. Procedures developed by Ball *(2, 3)* for evaluating heat, at a point representing the lowest rate of heat penetration in a food, in terms of its equivalent in minutes at 250° F. are reliable. There is so much evidence in support of this that it hardly seems necessary to consider it to be an assumption.

c. Equations derived by Olson and Jackson *(8)* for estimating the value of j (the "lag" factor) for curves representing heating at different points in a container of conduction-heating food are reliable. Again there is no reason to question the reliability of these when properly applied, since they were derived from the fundamental equation describing conduction heating.

Procedure for evaluating processes for conduction-heating foods. During a thermal process, the severity of heating of a conduction-heating food in a container varies from geometrical center to wall of the container, becoming progressively more severe as the wall is approached. Stumbo *(10)* described this gradient of severity by picturing a series of imaginary nested containers inside the real container. These containers were considered as cylindrical and decreasing in size from wall to geometrical center of the real container progressively in accordance with a uniform decrease in length and diameter. He further considered that severity of heating was essentially the same at all points on the surface of any one such imaginary cylinder. It was noted *(10)* that such a description did not represent the true picture, but that this would involve considering the imaginary containers gradually changing from cylindrical in shape near the wall of the real container to ellipsoidal or spherical near the geometrical center. Though it may be shown that picturing the imaginary containers as cylindrical constitutes a rather close approximation, it would be expected that considering their true shape in the development of an evaluation procedure might yield a more reliable procedure. Their true shape will be considered in the development described here.

In considering the severity of heating at points on the surface of these imaginary containers, the terminology suggested by Ball, Olson and Boyd *(4)* shall be adopted; that is, the surface

[1] Scientific Paper No. 1185, Washington Agricultural Experiment Stations, Pullman. Project No. 1121.

of any imaginary container shall be considered an iso-F-surface.[b] Also, as pointed out *(4)* any surface is iso-F because it is iso-j. This becomes immediately apparent upon inspection of the equation presented by Ball *(2)* for calculating process time.

$$P_R = f_h \log \frac{jI}{g} \qquad (1)$$

For all points in a container of conduction-heating food subjected to a specified heat process, B_R, I, and f_h are invariant. The value of F depends on the value of g attained during process. Then since g can vary only as j varies, any heating which is iso-F is necessarily iso-j. For this reason the regions of the container representing the surfaces of the imaginary containers referred to above shall henceforth be termed iso-j-surfaces or regions. These regions should be pictured as shells, the walls of which are intinitesimal in thickness.

It seems appropriate at this point to repeat an hypothesis upon which the newer methods of process evaluation *(5, 6, 11)* are based. In order to evaluate the capacity of a heat process to reduce the number of bacteria in a container of food, consideration of the heat treatment given any single point in the container is not sufficient. Accurate evaluation can be accomplished only if all points in the container are considered, the result of the heat process as it concerns the whole container being the sum of effects at all points throughout the container.

The fact that it is possible to describe iso-j-regions within the container greatly simplifies the task of evaluation. It is possible to describe these regions by employing the following equation developed by Olson and Jackson *(8)*:

$$j = j_c J_0\left(R_i \frac{r}{a}\right) \cos \frac{\pi y}{2b} \qquad (2)$$

In this equation:

- j = j at any designated point in the container.
- j_c = j at the geometrical center of the container.
- $J_0(x)$ = zero order Bessel function of x.
- R_i = the first positive root of $J_0(x) = 0$. It is a constant, the numerical value of which is 2.4048.
- r = distance, along the container radius, of the designated point from the vertical axis of the container.
- a = radius of the container.
- y = distance of the designated point above or below a horizontal plane bisecting the container midway between its two ends.
- 2b = container height, or length.

Employing equation (2), a number of iso-j-regions, from center to wall of a No. 10 (603 × 700) can of a conduction-heating food product, were described. These regions are depicted graphically in Figure 1. In the graph a plane bisecting the container through its longitudinal axis is represented. Since the regions are symmetrical about the geometrical center, regions are indicated in the figure only for the upper right-hand quadrant of the container. Each trace in the quadrant represents an iso-j-region of infinitesimal thickness. It is obvious that if any one of the traces near the geometrical center were extended through the other 3 container quadrants and rotated about the vertical axis, an ellipsoidal-like figure would be described. Also, if the same were done with a trace near the container wall, a figure more nearly resembling a cylinder would be described. This verifies the prediction mentioned above as to the true shape of imaginary containers, the surface of any one of which represents an iso-j-region. The true nature of iso-j-regions was fully described by Ball, Olson, and Boyd *(4)*. Also, they pointed out that the volume enclosed by any iso-j-region might be determined graphically by the method described in a number of elementary mathematics books for determining the volume of a solid of revolution.

[b] F as used here refers to the effectiveness of a heat treatment in terms of its equivalent, with respect to its capacity to reduce the number of a particular kind of bacteria, in minutes at 250° F.

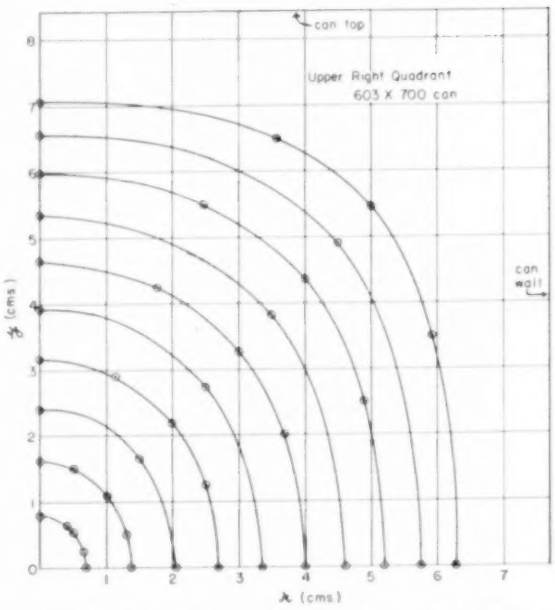

Figure 1. Curves representing a number of iso-j-regions in a 603 x 700 can of conduction-heating food.

It has been shown above that iso-j-regions can be described and the volume enclosed by them determined. It follows that the F value characterizing the heat treatment received during a specified process by any such region may be readily calculated using the method described by Ball *(2, 3)*, that is, by the equation:

$$F = \frac{f_h}{(f_h/U)_j} \qquad (3)$$

It should be noted that this relationship was described for heating at the geometrical center of a container of food for which the j value of the cooling curve was considered to be 1.41. This is probably an acceptable approximation for cooling of the center point, but undoubtedly considering the j value of the cooling curve for other points to be 1.41 will introduce some error. This will be discussed further later, but for the time being it is convenient to consider the equation valid for all points because of complications which would result in considering different j values for cooling at the different points involved.

The following equation was presented *(10)* to describe the death of bacteria as occurring logarithmically with time (usually minutes) of exposure to a constant temperature:

$$U = D(\log a - \log b) \qquad (4)$$

Where:

- U = time of heating.
- D = time required to kill 90% of the cells (spore or vegetative).
- a = number of viable cells present initially.
- b = number of viable cells present after heating time U.

By rearranging equation (4) we obtain an expression equal to the fraction of cells remaining viable after heating time U.

$$b/a = \frac{1}{\log^{-1} U/D} \qquad (5)$$

Now if U is expressed in terms of its equivalent in minutes at 250° F. equation (5) becomes:

$$b/a = \frac{1}{\log^{-1} F/D_r} \qquad (6)$$

Note that the D value when it refers to destruction at 250° F. has been designated D_r. Since this term is used so frequently,

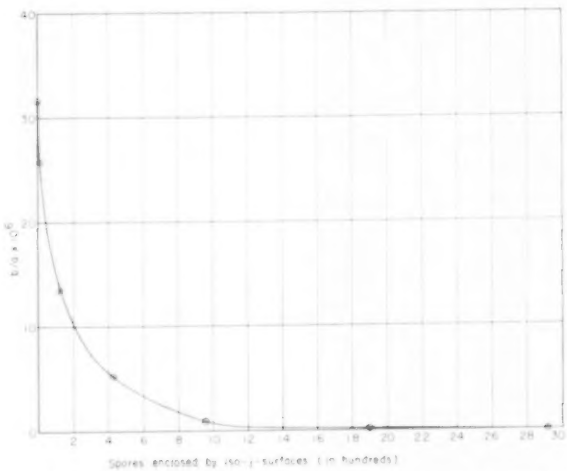

Figure 2. A typical curve showing the b/a fractions remaining after process in relation to the number of spores initially enclosed by iso-j-regions of concern (see text for conditions represented).

such designation avoids cumbersome description each time it is employed.

If uniform contamination of a food product with bacterial spores of known heat resistance is assumed, it is evident that by use of equation (6) the fraction surviving in any iso-j-region of a container of food subjected to a specified heat process may be readily calculated. In making such a calculation the F value of the heat treatment received by a designated region would be determined by use of equation (3) and the fraction surviving by use of equation (6). If fractions surviving in a number of iso-j-regions across the container are determined and plotted on plain coordinate paper against volumes enclosed by the respective iso-j-regions, a curve will be described, the area beneath which will be proportional to the fraction surviving in the entire container. Likewise, if these fractions are plotted against the number of spores enclosed by the iso-j-regions, the area beneath the curve obtained will be proportional to the number of spores surviving. Such a plot appears in Figure 2. The following values were assumed for the purpose of ascertaining the values for plotting the curve in Figure 2.

RT = 240° F. = retort temperature.
F_c = 4.5 = F value of heat received by geometrical center.
f_h = 195 = value representing slope of heat penetration curve.
IT = 140° F. = Initial food temperature.
m + g = 180° F. = RT minus cooling water temperature.
j_c = 1.82 = j for heating at the geometrical center.
z = 18° F. = value representing slope of thermal death time curve.
D_r = 1.00 = time to destroy 90% of spores at 250° F.
Initial contamination = ten spores per c.c. of product.
Can (603 × 700) volume = 3134 c.c.
Can size (inside dimensions) = height = 16.828 cm., diameter = 15.398 cm.

Using a planimeter the area beneath the curve in Figure 2 was determined and found to represent survival of 0.007 spores, or 7 spores per thousand containers.

Though the graphical procedure just described no doubt gives more reliable values than that described elsewhere (*11*), it is no less laborious and time-consuming. However, from values obtained by this procedure it has been possible to develop a relatively simple mathematical procedure. Development of the latter shall be described in order to demonstrate that values obtained by use of it should be as reliable, if not more so, as those obtained by use of the graphical procedure just described.

In attempting to find a relationship which was subject to simple mathematical expression it was noted that, when the differences between F values characterizing heat treatments received by the different iso-j-regions and the F value characterizing the heat treatment at the geometrical center were plotted against fractions of can volume enclosed by respective iso-j-regions, virtually a straight line was obtained, until the volume fractions exceeded about 0.4. In other words, if we designate the F value characterizing the heat treatment received by any iso-j-region as F_x, the F value characterizing the heat treatment received by the geometrical center as F_c, and the fraction of total can volume enclosed by any iso-j-region as v, then $F_x - F_c$ plotted against v is essentially a straight line so long as values of v do not exceed about 0.4. Values obtained for processing conditions described above in connection with the graphical procedure were plotted to obtain Figure 3.

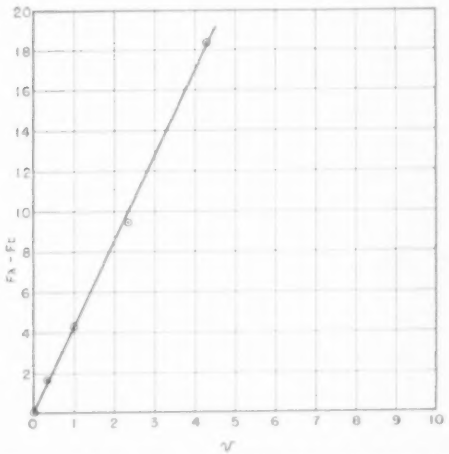

Figure 3. A typical curve showing the relationship between F_x - F_c and v for the container area of concern (see text for conditions represented).

A study of Figure 2 reveals that, under the processing conditions imposed, survival was negligible outside an iso-j-surface enclosing much less than 0.4 of the can volume. In fact, outside an iso-j-surface enclosing about 0.06 of the can volume. Further study of other processing conditions likely to be encountered revealed that $(F_x - F_c) : v$ curves were always essentially straight for the portion of the container where significant survival could be expected. A slight divergence, however, was sometimes noted. That which appears for the curve in Figure 3 is the greatest observed for any of the processing conditions studied. Since extremes were chosen for study it is unlikely that greater divergence will be encountered. However, there would seem to be a logical explanation for some divergence, since as noted earlier the method employed for calculating F values considered the j value for the cooling curve always to be 1.41. It is known that j values for center cooling are often less than 1.41, and certainly we would expect those for cooling at points nearer the container wall to be less than those for center cooling. Such a situation would result in calculated F values being somewhat greater than the true values. This explanation is wholly compatible with the observed divergence. Therefore, and because the divergence is so slight, it is believed justifiable from the practical point of view to consider $(F_x - F_c) : v$ curves straight for the portion of the container of concern in process evaluation. Moreover, it is believed that to consider them so should tend to correct for errors introduced by considering j values for all cooling curves to be 1.41. The reason for this belief should become obvious as the mathematical procedure is developed.

On the basis of the above discussion, the equation for the $(F_x - F_c) : v$ curve may be written as follows:

$$F_x - F_c = mv \qquad (7$$

in which m is the slope of the curve. Also we note from equation (6) that,

$$b/a = 10^{-F_c/D_r} \tag{8}$$

If the F value representing the equivalent of all heat received by the entire container during process is designated as F_e, then, considering effects throughout the container:

$$b/a = 10^{-F_e/D_r} \tag{9}$$

The term b/a in this equation would then equal the fraction of the number of spores, initially present in the entire container, which should be viable at the end of the process. Also from equation (8) it is evident that,

$$b/a = 10^{-F_s/D_r} \tag{10}$$

where b/a in this case would equal the fraction of the number of spores, initially present in any designated iso-j-region, which should be viable after the process. (Recall that each iso-j-region is infinitesimal in thickness.) Then if the volume of the container is considered as unity,

$$10^{-F_e/D_r} = \int_0^1 10^{-F_s/D_r}\,dv \tag{11}$$

But from the equation (7),

$$F_s = F_c + mv \tag{12}$$

By substitution, equation (11) becomes,

$$10^{-F_e/D_r} = \int_0^1 10^{-(F_c+mv)/D_r}\,dv \tag{13}$$

From which,

$$10^{-F_e/D_r} = -10^{-F_c/D_r}\,\frac{D_r}{(\ln 10)m}\left[10^{-mv/D_r}\right]_{v=0}^{v=1}$$

or,

$$10^{-F_e/D_r} = 10^{-F_c/D_r}\,D_r\,(1 - 10^{-m/D_r})/2.303m \tag{14}$$

Equation (14), though usable, was found cumbersome to handle and consequently, it was simplified in the following manner. Equation (7) was rearranged to obtain,

$$m = \frac{F_s - F_c}{v} \tag{15}$$

Substituting and evaluating for a number of extreme processing conditions it was found that $10^{-m/D_r}$ was always negligible as compared with unity. This then allowed equation (14) to be reduced to:

$$10^{-F_e/D_r} = 10^{-F_c/D_r}\,D_r v/2.303\,(F_s - F_c)$$

or,

$$-F_e/D_r = -F_c/D_r + [\log D_r + \log v] - [\log 2.303 + \log (F_s - F_c)]$$

and,

$$F_e = F_c - D_r\{[\log D_r + \log v] - [\log 2.303 + \log (F_s - F_c)]\} \tag{16}$$

Use of equation (16) in process evaluation would involve the determination of corresponding values of F_s and v each time an evaluation were made, or the establishment of tables of these parameters for different processing conditions. But fortunately, elimination of this inconvenience has been found possible. Since $F_s - F_c$ plotted against v gives a straight line for the portion of the container which must be considered, a numerical value may be assigned to v if the designation is made that F_s is always to be the F value of the heat treatment received by the iso-j-region enclosing a fraction of the can volume equal to the assigned value of v. It has been found convenient to employ the value v = 0.19 for further simplification of equation (16). The reason for choosing this value will be explained in discussions relating to the application of the final equation obtained. Equation (16) may now be written,

$$F_e = F_c + D_r[-\log D_r - \log 0.19 + \log 2.303 + \log (F_s - F_c)]$$

or,

$$F_e = F_c + D_r\left(1.084 + \log\frac{F_s - F_c}{D_r}\right) \tag{17}$$

where, v = 0.19.

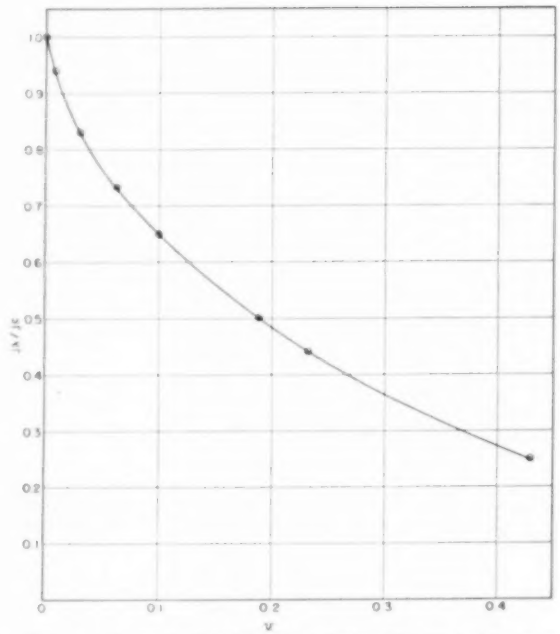

Fig. 4. A curve showing the relationship of j_s / j_c to v for any cylindrical food container.

Equation (17) would be made still more convenient in application if the value of F_s could always be determined from its relationship to a corresponding value of F_c. It was noted in developing the graphical procedure above that, for a designated process, F varies across the container only with variations in j and g. It has been pointed out by Ball, Olson and Boyd *(4)* that, for any value obtained by dividing the value of j associated with an iso-j-region by the value of j associated with the center, there is always a corresponding value of v (fraction of can volume enclosed by the iso-j-region). It was also pointed out that this relationship is independent of container size and shape (reference here to cylindrical containers). The validity of these observations has been verified. A curve describing the relationship appears in Figure 4. This curve was obtained by plotting j_s / j_c against v, where j_s refers to the j associated with any iso-j-region, j_c to the j associated with the geometrical center, and v to the fraction of can volume enclosed by any iso-j-region. From this curve and by calculation it has been found that when v = 0.19, $j_s / j_c = 0.5$. Now for a given process,

$$B_{ss} = f_h \log \frac{j_c I}{g_c} = f_h \log \frac{j_s I}{g_s}$$

or,

$$j_c/g_c = j_s/g_s$$

and,

$$g_s = \frac{j_s}{j_c}\,g_c \tag{18}$$

Then when v = 0.19,

$$g_s = 0.5 g_c \tag{19}$$

Therefore,

$$F_e = F_c + D_r\left(1.084 + \log\frac{F_s - F_c}{D_r}\right), \text{ when } g_s = 0.5 g_c \tag{20}$$

Equation (20) may be considered as a generally applicable equation for evaluating heat processes for conduction-heating foods in cylindrical containers. Any value of F_e will be in terms of the equivalent of the heat process, in minutes at 250° F., with respect to its capacity to reduce the number of bacteria of any given heat resistance. Heat processes of equal F_e value applied to the same product in containers of different size should reduce the number of viable bacteria (of given heat resistance)

to the same level per unit volume of product regardless of container size. That this is not true equivalency from the standpoint of possibilities for product spoilage shall be discussed later.

Now, to demonstrate the simplicity of equation (20) in application, the process data employed above in describing development of the graphical procedure will be used. They are as follows:

RT = 240° F.	$j_c = 1.82$
$F_s = 4.5$	z = 18° F.
$f_h = 195$	$D_r = 1.00$
IT = 140° F.	Can volume = 3134 c.c.
m + g = 180° F.	Initial contamination = 10 spores/c.c.

What is the F_s value of this process?

Solution:

$$F_i = \log^{-1}\frac{250 - RT}{z} = \log^{-1}\frac{250 - 240}{18} = 3.594$$

$$U_c = F_s F_i = 4.5 \times 3.594 = 16.173$$

$$f_h/U_c = 195/16.173 = 12.057$$

From f_h/U : g tables (Ball, *3*) find:

For z = 18, m + g = 180, and $f_h/U_c = 12.057$ $g_c = 10.05$

$$g_s = 0.5\, g_c = 10.05 \times 0.5 = 5.025$$

Again from f_h/U : g tables, find:

For $g_s = 5.025$, $f_h/U_s = 4.468$

$$U_s = f_h/4.468 = 195/4.468 = 43.65$$

$$F_s = U_s/F_i = 43.65/3.594 = 12.16$$

By substitution in equation (20)

$$F_s = 4.5 + 1.00\left(1.084 + \log\frac{12.16 - 4.5}{1.0}\right)$$

$$F_s = 6.468$$

It will have been noted that application of equation (20) requires no tables of parameters other than those published in 1928 by Ball (*3*). Also, that 0.19 was chosen for the value of v in the derivation of equation (20) because of the convenient corresponding value (0.5) of j_s / j_c which is always employed in calculating g_s. Now the F_s value obtained by equation (20) may be compared with the one which may be obtained for the same process evaluated graphically. From solution of the problem graphically it was found that the number of spores per container should have been reduced from 31,340 to 0.007. Then,

$$F_s = D_r(\log a - \log b) = 1(\log 31{,}340 - \log 0.007)$$

$$F_s = 4.496 + 2.155 = 6.651$$

This value compares very favorably with the 6.468 obtained by equation (20). It can be shown that the divergence noted is due to the fact that in deriving equation (20) the $(F_s - F_c)$: v curve was considered as a straight line, while in the graphical procedure the observed curve was employed. As noted above, considering this curve to be straight tends to correct for errors introduced by considering the j value for any cooling curve to equal 1.41. Therefore, the F_s value obtained by equation (20) is unquestionably more reliable than that obtained by the graphical procedure.

Equivalence of processes for conduction-heating foods. It was stated above that heat processes of equal F_s value applied to the same product in containers of different size should reduce the number of viable bacteria (of given heat resistance) to the same level per unit volume of product regardless of container size. Since the level to which bacteria are usually reduced is quite low, it would be expected that survivors would occur singly in different containers. Therefore, equivalent processes, from the standpoint of their allowing equal quantities of food the same opportunity of spoilage, should be those which would leave the same number of bacteria per container rather than per unit volume of product. Economically this might not constitute exact equivalency, but practically it would seem the logical basis for departure in considering the problem. Then how should F_s values compare for equivalent processes to be applied to a given product in containers of different size? This question was answered by Gillespy (*5*). He presented an equation describing the comparison, which, employing symbols consistent with those used above, may be written as follows:

$$F_{s_2} = F_{s_1} + D_r \log\frac{V_2}{V_1} \qquad (21)$$

In this equation V_1 and V_2 refer to volumes of the two containers concerned. By way of example, if the F_s value for a process given a product packed in 603 × 700 cans were 6.468 as found above, what would be the F_s value of an equivalent process for the product in 211 × 304 cans?

$$F_{s_2} = 6.468 + \log\frac{243}{3134}$$

F_{s_2} = 5.357 = F_s value for processing product in 211 × 304 cans

Extending the comparison, the F_c value of the process for the product in 211 × 304 cans may be determined by use of equation (20). In a sense this is a trial procedure; however, only 2 forward calculations and interpolation are required to obtain a very close approximation. Since the procedure is one essential to solution of a number of processing problems, the main steps in it will be demonstrated. By procedures described by Olson and Jackson (*8*) the f_h value for the product in 211 × 304 cans was found to be 35. Assuming the j_c value to be the same as for the 603 × 700 cans of product, no additional values other than those specified above for processing the product are required for the calculations. Now, two F_c values are chosen which are logically in the range of the one to be determined. For example, it is obvious that the F_c will be lower than the F_s, and logical that, for an F_s value of 5.357, it is not likely to be lower than 3.5. Therefore, the values 4.5 and 3.5 might be logically chosen for trial calculations. The next step is to calculate the F_s values for processes having these F_c values.

$$F_s = F_c + D_r\left(1.084 + \log\frac{F_s - F_c}{D_r}\right), g_s = 0.5\, g_c$$

When

$$F_{c_1} = 3.5,\ F_{s_1} = 4.934$$

When

$$F_{c_2} = 4.5,\ F_{s_2} = 5.971$$

Now by interpolation as follows:

$$F_c \text{ desired} = F_{c_1} + \frac{F_{c_2} - F_{c_1}}{F_{s_2} - F_{s_1}}(F_s \text{ desired} - F_{s_1}) \qquad (22)$$

And,

$$F_c \text{ desired} = 3.5 + \frac{4.5 - 3.5}{5.971 - 4.934}(5.357 - 4.934)$$

$$F_c \text{ desired} = 3.908$$

To check this F_c value it is only necessary to substitute back in the equation for F_s. It is found that,

$$F_s = 3.908 + 1\left(1.084 + \log\frac{6.225 - 3.908}{1}\right)$$

$$F_s = 5.357$$

Slide rule accuracy is sufficient for calculations such as those just demonstrated.

It has been shown above that F values for equivalent processes, under conditions specified, for the same product packed in cans of 2 different sizes are as follows:

Can Size	F_s	F_c
211 × 304	5.357	3.908
603 × 700	6.468	4.500

These considerations would certainly indicate that processes which are equivalent with respect to preventing product spoilage must have, not the same, but different F_c values when applied to conduction-heating products in containers of different size. This is in contrast to common belief and practice based on the older methods of process evaluation (*2, 3*).

While discussing this subject it should be interesting to investigate how changing the retort temperature affects the F_s value, even though the F_c value is unchanged. Assume that a 307 × 409 can is used to pack a product and that heat penetration tests have established the f_h value to be 60 and the j value to be 1.9. Now the cans of product are divided into 2 lots; one lot is to be processed with a retort temperature of 260° F. and the other with a retort temperature of 230° F. Each lot is given a process having an F_c value of 4.5. What would be the F_s or true sterilizing value in each case?

Case 1	*Case 2*
Where RT = 260°	Where RT = 230° F.
j = 1.9	j = 1.9
f_h = 60	f_h = 60
m + g = 180	m + g = 150

Assume for both cases spore resistance values of $z = 18°$ F. and $D_r = 1.50$.

Case 1:

$$F_s = F_c + D_r\left(1.084 + \log\frac{F_h - F_c}{D_r}\right), g_h = 0.5\,g$$

$$F_s = 4.5 + 1.5\left(1.084 + \log\frac{20.96 - 4.5}{1.5}\right)$$

$$F_s = 7.685$$

Case 2:

$$F_s = 4.5 + 1.5\left(1.084 + \log\frac{5.79 - 4.5}{1.5}\right)$$

$$F_s = 6.029$$

It is quite obvious that the 2 processes just evaluated are far from equivalent though their F_c values are the same. A difference of 1.656 in sterilizing values cannot be considered unimportant. If the process having an F_s value of 7.685 allowed any amount of spoilage, the one having the F_s value of 6.029 would allow more than ten times as much. Or, if the latter were adequate the former would constitute definite overprocessing with resultant loss of product quality. In either event such a difference could be economically quite important.

There is one other condition which if varied could cause effects similar to that noted for varying the retort temperature; namely, the initial temperature of the food product.

Procedure for evaluating processes for convection-heating products. Because of product movement in a container of convection-heating product, heating is nearly uniform throughout most of the container contents. Though it is known that some portions of the container contents receive somewhat more severe heating than others, the product movement is a complicated thing to analyze with any high degree of confidence. It would appear to be too complicated for generally applicable mathematical description. Therefore, until more is known of the mechanism of heat transfer in convection-heating foods, it is believed safest, from the standpoint of process evaluation, to consider them to heat uniformly throughout the container, and that heating throughout is the same as at the geometrical center. It is known that heating near the container wall is somewhat more severe than it is at the center. It is also known that the slowest heating region is generally a short distance above the bottom, if container agitation is not responsible for product movement. Therefore, it would appear, in view of present knowledge, that heating at the geometrical center might best represent average conditions throughout.

If the proposition is considered in this manner, process evaluation procedures for convection-heating products are made considerably simpler than those for conduction-heating products. The equation for F_s may be written as follows:

$$F_s = D_r\,(\log a - \log b)$$

If the value of the term *a* in this equation is always taken as the number of spores (of designated heat resistance) initially present per container and the value of the term *b* as the number of spores per container remaining viable after process, container size is automatically accounted for. The relationship of F_s values for containers of different size may, as for conduction-heating products, be expressed as follows:

$$F_{s_2} = F_{s_1} + D_r \log\frac{V_2}{V_1}$$

Then on the basis of the above stated premise, the F_c value should always be made to equal the F_s desired. It is evident here, as for conduction-heating products, that equivalent processes for the same product packed in 2 cans of different size would not have the same F_c values.

From the F_c values determined in the manner described, process specifications may be computed by methods in common use. Processes for convection-heating products arrived at in this manner should be virtually equivalent, and, if calculated by using a properly chosen reference process as the basis, should prove quite reliable in application.

Effect of organism resistance on F_s value of process. Though this point was well covered by Gillespy *(5)*, it will also be discussed briefly here for the express purpose of emphasizing its importance. It is obvious, from the equations given above for evaluating processes for both conduction- and convection-heating products, that the value of F_s depends upon the value of D_r. Though less obvious from the equations, the value of F_s also depends on the value of z; however, variations among values of z for different organisms of importance in canning are far smaller and consequently much less important than variations in values of D_r. Values of z are usually in the range of 15° to 20° F. while values of D_r for spores of the same organisms (including a number of strains and species) are generally in the range of 0.1 to 3.0.

For the case, considered above, of the conduction-heating product processed with a retort temperature of 260° F., it was found that the F_s value of the process was 7.685. In the problem solved the value of D_r was assumed to be 1.5 and the value of z to be 18° F. What would be the F_s value of this same process if the value of D_r were 0.1 and the value of z were the same as before? In this case,

$$F_s = 4.5 + 0.1\,[1.084 + \log\,(20.96 - 4.5)/0.1]$$

$$F_s = 4.83$$

The significance of these comparative values cannot be fully appreciated without interpreting them in terms of spore reduction. According to the equation,

$$F_s = D_r\,(\log a - \log b)$$

the process should, when spores for which the D_r value is 1.5 are involved, reduce the number of spores from 10^{12} to 1.0. This same process should, when spores for which the D_r value is 0.1 are involved, reduce the number of spores from $10^{80.3}$ to 1.0.

The above comparisons, particularly in view of the well known fact that spore resistance to heat is greatly affected by the nature of the food product, should serve to emphasize the urgent need for reliable data on spore resistance. Data of the type which is now indicated for accurate evaluation of thermal processes for foods are certainly far from adequate.

GENERAL DISCUSSION

Procedures for process evaluation developed and discussed above have been presented in the hope that they might serve a useful purpose in arriving at processes, for foods in cylindrical containers, which are more nearly equivalent in sterilizing capacity than are those now in common use. Since none of the conditions discussed here received full consideration in formulating process specifications now in common use, it is hoped that such specifications may be reviewed in light of these newer methods of process evaluation. Since the least severe processes generally employed have proved adequate in most instances, it would seem only logical that quite a number are considerably more severe than necessary, or than desirable from the standpoint of product quality.

Such a review would have been an inordinate task by the more complicated procedures employing the newer concepts of evaluation. It is not considered to be such now in light of the ease with which the newer methods may be applied through the procedures described above.

In view of the analysis herein presented, perhaps the statement *(1)* that there is "little likelihood that greatly different results will be obtained by application of the new methods as compared with the methods in common use," should be weighed quite carefully. It is firmly believed that proper application of the newer methods should prove economically important to the food processor. It is further believed that application of the newer methods should result in improvement of both the organoleptic and nutritive quality of a number of important thermally processed food items. The possibilities for further improvement in thermally processed foods are great. It is not believed or contended that application of the newer methods will in any way constitute the final answer, but merely a step in that direction.

Food products exhibiting broken heating curves have not been treated in this presentation because a great amount of additional work will be necessary before evaluation of processes for them is subject to reasonably accurate mathematical expression. Until additional information has accumulated, reasonable approximations can be made by currently employed methods and judgment in light of the newer concepts of process evaluation.

In developing the procedures described above, the basic assumption was made, as noted, that the order of death of bacteria subjected to moist heat is logarithmic. There is insufficient evidence at present to rule out exceptions to such an assumption. However, for cases in which the order of death has been reported as not being strictly logarithmic, there has been no other generally applicable mathematical description for the destruction (or survivor) curves observed. Should it finally be determined that the order of death of bacteria is not strictly logarithmic and that destruction curves could be described better mathematically than is now possible by considering death to be logarithmic, the procedures for evaluating processes should of course be revised accordingly. However, on the basis of present knowledge, it would appear that to describe death as generally occurring logarithmically with time of exposure to a constant temperature constitutes the closest approximation possible. And from the standpoint of establishing equivalency among heat processes for sterilizing foods, full consideration of the concept in methods of evaluation should prove wholly practical.

SUMMARY

Convenient procedures for evaluating thermal processes for foods in cylindrical containers have been developed and their application demonstrated through use of equations implementing the procedures. The procedures described are designed to integrate heat effects throughout the container and to translate the sum into its equivalent, in minutes at 250° F., with respect to its capacity to reduce the number of viable bacteria in the container. It is contended that the F_s values which may thus be determined more nearly represent true sterilizing values than do F_c values obtainable by methods now in common use. Further, by proper adjustment of processes with full consideration of their F_s values, it is possible to arrive at processes, employing widely different processing conditions, which are virtually equivalent from the standpoint of their allowing product spoilage.

Possibilities for improvement of thermally processed foods through application of the newer methods of process evaluation have been discussed. The urgent need for more data on thermal resistance of important food spoilage bacteria has been emphasized by the developments described.

Acknowledgment

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The Effect of Sodium Hexametaphosphate on Flavor and Texture of Frozen Cottage Cheese

EVA MEDVED, INEZ PRUDENT, AND LOUIS H. BURGWALD

School of Home Economics and Department of Dairy Technology, The Ohio State University, Columbus, Ohio

(Manuscript received February 28, 1953)

Cottage cheese was manufactured by the short-time coagulation method, using pasteurized skim milk and two levels of sodium hexametaphosphate (Calgon). Tests made to determine the effect of this salt on the texture and flavor of frozen cottage cheese indicated that at the levels used, there was no beneficial effect on the texture or flavor of the cheese after thawing.

Seasonal variations, shortages, and surpluses of skim milk suggest that storage of cottage cheese could solve the problem of securing a profitable market for skim milk in the spring and meeting the year around demand for cottage cheese. In the past, most investigators have concerned themselves with setting forth various directions for making cottage cheese, with some emphasis placed on factors influencing flavor and body characteristics. There appears to be little information available on the production of cottage cheese for frozen storage—a means of accomplishing more strategic marketing of skim milk.

Need exists for an agent which can be added to cottage cheese during the manufacturing process and before freezing which will not be objectionable and which will prevent the formation of a grainy, friable texture when defrosted. For this study, sodium hexametaphosphate (Calgon) was chosen as the agent because it has produced desirable characteristics in other cheeses *(3, 7)* and because of its ability to combine with protein and to sequester calcium *(4, 10)*. Previous investigators have indicated that usual methods for manufacturing cottage cheese do not produce an acceptable cheese upon thawing.

Davis *(2)* in studying the effect of storage factors on cottage cheese, found that when the curd is frozen and thawed, the result is usually a mushy, grainy cheese with a slight increase in acid flavor.

Marquardt *(6)* reported the use of frozen cottage cheese in New York State. The curd to be frozen was prepared in the usual manner. It was thoroughly washed and lightly salted but never creamed. The curds were packed into 50-pound tins and frozen immediately at 0° to —20° F. (—17.8 to —28.9° C.). The curd was thawed by placing the tins into water at room temperature. The thawed curd had a fine particle size, but this was not considered objectionable.

North and Little *(8)* were granted a patent covering the manufacture of a special curd for cottage cheese that was to be frozen. The cheese was made by setting the curd with a coagulating enzyme, such as rennet or pepsin, and cutting the curd when the whey acidity was between 0.25 and 0.45%. The curd was cooked to produce a rubbery, tough body, frozen, and then thawed to produce a product with the desirable characteristics of fresh cottage cheese. North *(9)* stated that experimental work was still being conducted on this patent due to unexpected difficulties.

Calbert *(1)* reported that many different methods were tried for freezing cottage cheese and the resulting thawed product was a very soft, mealy cheese.

Moore and Schilb *(7)* used sodium hexametaphosphate as an agent in hard cheese to help emulsification and prevent "oiling-off" to a certain extent.

Cheese with a distinctive flavor and consistency was produced in Germany by Guttenberg and Firgan *(3)* through the use of certain fluxes in addition to phosphate compounds. These investigators produced a cheese that was soft and melted when used for cooking. This special property was attained by homogeneously incorporating in cheeses small quantities of alkaline polyphosphates.

Partridge and Texter *(10)* reported that Calgon, as a cheese-melting salt, was believed to interact with the casein as well as to affect the properties by sequestering calcium.

EXPERIMENTAL METHOD

Pasteurized skim milk was used throughout the study. A known concentration of sodium hexametaphosphate was added followed by the addition of an active starter.* The starter was used at the rate of 8%. Saturated calcium chloride solution was added at the rate of 1 cc. per 100 pounds of milk. Rennet was the coagulant used and it was added at the rate of 1 cc. per 1,000 pounds of milk. The rennet was diluted about 40 times its original volume with clean, cool water just before adding it to the milk.

Preliminary steps were taken to determine the levels of sodium hexametaphosphate to be used in the experimental study. Commercial equipment was used to manufacture the cheese by the short time coagulation method. Each batch consisted of 3 cheeses, a control, a cheese with 0.12% and one with 0.36% sodium hexametaphosphate. A minimum amount of milk (30 gallons) was used in each vat. The milk was set at 90° F. (32.22° C.). Acidity was determined by titrating with 0.1 N sodium hydroxide solution, and the curd was cut when the whey had an acidity of 0.50%. A $\frac{5}{8}$ inch stainless steel curd knife was used to cut the cheese curd. The curd was heated to a temperature of 120° F. (48.89° C.) after which the heat was turned off and additional firming was accomplished by allowing the curd to remain in hot whey. The firmness of the curd was determined by placing a small portion into cold water for 5 minutes and examining it. The curd was washed 3 times, twice with water at 85° F. (29.44° C.) and once with water at 36° F. (2.22° C.). The curd was drained thoroughly. The cottage cheese was packed into waxed pint containers and frozen immediately at —10° F. (—23.33° C.). After freezing, the cheese was transferred to a freezing cabinet set at 0° F. (—17.79° C.) for storage.

Objective tests included measurement of texture by a precision penetrometer, moisture determination and phosphorus determination. For the penetrometer test, 100 g. of cheese were

* Prepared from Hansen's Lactic Ferment Culture.

weighed into a 250 cc. beaker, the surface of the cheese was covered with a cardboard disc to fit the beaker (2½ inches in diameter) and a 210 g. weight of almost the same diameter (2¼ inches) as the beaker was placed upon top of the cardboard for 30 seconds. As soon as the weight and cardboard were removed, the blade of the penetrometer was adjusted level with the cheese surface. Penetration took place for 10 seconds and after this period, the penetration readings were taken and recorded to 0.1 mm. The plunger used for penetration consisted of a metal rod with a losely attached knife blade 1½ inches in horizontal measurement by one inch in width. The blade was centered above the cheese surface, so that when it was released, a cut would be made through the center of the surface of the cheese in the beaker. Three other readings were taken after rotating the beaker so that the total of 4 impressions on each sample resembled a pie cut into 8 equal pieces. The above procedure was repeated on the duplicate sample for each cheese. Penetrometer readings were taken before storage and at the end of one, 4 and 8 weeks of storage.

The test for moisture determination of cheese described in the A.O.A.C. Manual, seventh edition, was used in this study. Moisture determinations were made in duplicate for each cheese before storage and at the end of 8 weeks of storage.

Three different series of cheese were used for phosphorus determinations. The cheese had been in storage for 8 weeks. These determinations were made by using the method described by McCrudden *(5)*.

Organoleptic tests were used to score the flavor and texture of cottage chese before and at various intervals during storage. The taste panel consisted of 4 judges from the staff of The Ohio State University.

Four different batches of cottage cheese were creamed to determine the effect of the addition of Calgon on the cream absorbing property of cheese. The cheese was thawed at room temperature. One part of 12% cream was mixed with 2 parts by weight of thawed cheese curd and held for 6 hours in a household refrigerator.

RESULTS AND DISCUSSION

In this study, the effect of sodium hexametaphosphate (Calgon) on flavor and texture of frozen cottage cheese was investigated. The results of the penetrometer test before storage indicated that cheese containing Calgon possessed a softer texture than the control cheese. It was noted that penetrometer readings for the control cheese before storage were usually lowest and for the 2 levels of Calgon were approximately equal (lower score indicated firmer texture). After storage the control cheese quickly reached a higher reading at which it was stable but the Calgon cheese readings increased constantly and the 0.12% Calgon cheese reading increased more than the 0.36% Calgon cheese. Average penetrometer readings, before and after storage, can be found in Figure 1. These results would indicate that between a Calgon concentration of 0.12 and 0.36%, there is little or no effect on texture before storage.

Organoleptic tests were also used to measure the effect of Calgon on the texture of frozen cottage cheese. All cheeses were scored by 4 judges. The perfect score was 10. To aid in judging, a scoring key ranging from *perfect* to *very poor* and corresponding to the number values from 10 to 1 was used. The average score for all 7 batches of each cheese before storage was as follows: control, 7.714; 0.12% Calgon, 7.179; 0.36% Calgon, 6.500. Using the scoring key, these averages were interpreted to read: control, *good*; 0.12% Calgon, *good*; 0.36% Calgon, *medium*. The results indicated that the texture of all the cheeses before storage was acceptable.

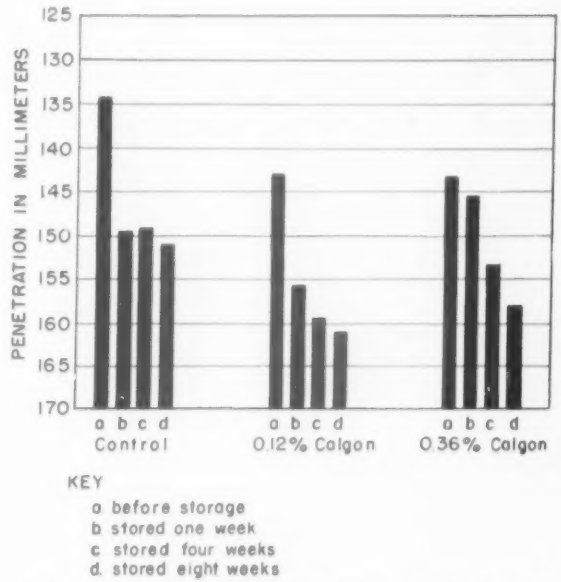

Figure 1. Average penetrometer readings for seven trials of frozen cottage cheese before and after storage.

The texture of these cheeses was scored by the same judges at various intervals during the 10-week storage period. The average texture scores of the 4 judges for the 7 batches were totaled and an average score for each of 9 storage intervals obtained. It was noted that the control after storage was always ranked first; 0.12% Calgon, was always ranked second, and 0.36% Calgon was always ranked last. Using the scoring key, these averages can be interpreted to read: control, *medium to fair* (scores range from 6.4 to 5.6); 0.12% Calgon, *medium to fair* (scores range from 6.1 to 5.2); 0.36% Calgon, *fair to poor* (scores range from 5.6 to 4.6).

Previous studies have indicated that the texture of the frozen curd was less desirable than the texture of fresh cheese curd. The results in this study were found to be consistent with those obtained in other studies on frozen curd.

Examination of the thawed curd by pressing gently between the fingers and stirring carefully with a spoon, revealed a curd which had a soft body, was easily broken apart and possessed a grainy texture. Cheese containing 0.12% Calgon seemed to have a softer, more grainy texture than either the control or 0.36% Calgon cheese, while 0.36% Calgon cheese was somewhat softer than the control. The results of the organoleptic test for texture and penetrometer readings for firmness supported the above observation. These results indicated that the addition of Calgon does not improve the texture of frozen cottage cheese.

The effect of sodium hexametaphosphate (Calgon) on the flavor of cottage cheese was also studied. The flavor of the cheese was scored at the same time as the texture by the same judges. The perfect score was 10. The average flavor score for all 7 batches of each cheese before storage was as follows: control, 7.357; 0.12% Calgon 7.071; 0.36% Calgon, 6.786. Using the scoring key, these averages were interpreted to read: control,

good; 0.12% Calgon, *good;* 0.36% Calgon, *medium*. A comparison of the total average scores for the control and 0.36% Calgon cheese indicated a difference of only 0.511. From these results, it can be seen that the range was not great, that the flavor of all 3 cheeses was acceptable and that Calgon did not produce an undesirable flavor, but that there was a gradual decrease in flavor due to storage.

Moisture determinations were made in duplicate on all cheeses before storage and again after 8 weeks of storage. The results obtained indicated that the moisture content of all cheeses before and after storage was approximately 80%.

Phosphorus determinations were carried out on 3 different batches of cheese. The average results obtained from this test through the use of the Evelyn Photoelectric Colorimeter were as follows: control, 160 mg. of phosphorus per 100 g. of cheese; 0.12% Calgon, 281.7 mg. of phosphorus per 100 g. of cheese; 0.36% Calgon, 378 mg. of phosphorus per 100 g. of cheese. From these results it was concluded that much of the Calgon added to skim milk was retained by the cheese curd produced.

To determine the effect of Calgon on the cream absorption of cottage cheese, the creamed cheese was examined by a specialist of the Ohio State Dairy Technology Department. All cheeses including the Calgon and control were rated both high and low. The results obtained indicated that Calgon had no appreciable effect on the cream absorbing property of the cheese curd.

CONCLUSIONS

Data obtained from this study indicated that the texture and flavor of all cheeses were acceptable before storage and that the texture and flavor decreased progressively in acceptability as length of storage increased. The thawed curd generally had a soft, grainy body which broke apart easily. The results also indicated that sodium hexametaphosphate (Calgon) had no appreciable effect on the cream absorbing property of cottage cheese curd nor on the moisture content. Much of the Calgon was retained by the cheese curd. It can be concluded that the addition of Calgon in the amounts used in these trials had no beneficial effects on the flavor or body and texture of frozen cottage cheese.

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Occurrence and Nature of Bacteria in Canned Beef[a,b]

JOHN C. AYRES and A. T. ADAMS

Bacteriology Department, Iowa State College, Ames, Iowa

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Methods are described for determining the incidence of total bacterial populations and spores in fresh and heat-processed beef. Studies, using these methods, are reported on fresh, canned, and heat-processed beef. Results show a need for further study of the facultative aerobe in canned meats since a large number survived a 20-minute heating period at 80° C.

Little information is available in the literature concerning the bacteriological status of beef from the time that the dismembered pieces of carcass leave the processing line until the meat has been canned and processed. Also, there is diverse opinion among canners with regard to the processing values (F_o) required for producing commercial sterility in canned meat products.

Sterilization periods advocated by laboratories associated with the canning industry assume the presence of large anaerobic spore loads of high heat resistance. However, counts made by Harriman, *et al. (6)*, by Burke, Steinkraus and Ayres *(3)*, and by Steinkraus and Ayres *(12)*, from fresh, cured and processed pork luncheon meat indicate much smaller numbers of anaerobic spores than were assumed in determining accepted process times. Whether counts of the order found in these 3 studies are general throughout the industry is not known.

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[b] This paper reports research sponsored by the Quartermaster Food and Container Institute for the Armed Forces, and has been assigned No. 418 in the series of papers approved for publication. The views or conclusions contained in this report are those of the authors. They are not to be construed as necessarily reflecting the views or indorsement of the Department of Defense.

It is generally known in the industry that lower sterilizing values result in canned meat having more desirable flavor and less mushy texture. Consequently, there is great need for adequate information regarding the source, nature and heat resistance of meat spoilage organisms in order to make possible the development of packing house practices and processing methods which will improve the product organoleptically without jeopardizing safety and keeping quality.

Unpublished findings of work conducted at the Iowa State College laboratories and verbal reports from representatives of at least 2 of the commercial meat packing plants [Vinton, *(15)*; Ogilvy *(11)*] indicate the presence of heat tolerant aerobes and, in particular, spore forming bacteria—both in fresh pork trimmings and in products receiving mild processes. According to Jensen, Wood and Jansen *(7)*, aerobic spore-forming bacilli ferment canned spiced ham with the production of gas when nitrate and sugar are present.

It is significant that although processing schedules used by various packers to provide satisfactory shelf life for canned meat products differ widely, no concrete evidence that any of these meats were understerilized has ever been received from the field *(13)*. Ecklund, Roberts and Benjamin *(4)* indicate that packers rely to some extent on the bacteriostatic effect of curing agents and a rigid program of plant sanitation for preventing microbiological action in the commercial product. Yet, it is apparent that basic information concerning the numbers and kinds of organisms associated with fresh and processed meat items is essential before sterilizing values lower than presently advocated can be adopted.

Although it is recognized that many studies will be needed before sufficient data have been accumulated to provide the required basic information, it is hoped that the investigation reported here will be one step in that direction.

EXPERIMENTAL

Three boned portions of round were shipped by express each week from the packing plant in Chicago to the college laboratory in Ames. Thirty-six matched sets of knuckle, inside round and outside round of cutter and canner grade beef were used during the study. Corrugated paperboard cartons served as outer shipping cases for the sets of beef in the first and second series of samples while permanent-type wooden-bottom, quilted-canvas shipping bags were employed in the third. Refrigeration of the meat in the shipping carton was provided by several polyethylene bags or 6-pound cans (of the type used for spiced luncheon meat) which had been previously filled with water and frozen. One or more of the following were used for insulation: paperboard, corrugated paper, newspaper, wrapping paper, absorbent industrial tissue, shredded paper, wood fiber, or quilted canvas. A layer of waxed paper, wrapping paper, or paperboard separated the cans of ice and packages of meat. The beef was placed in polyethylene bags.

Upon arrival at the laboratory the condition of the shipping carton, insulation and packaging film was recorded, the packages opened, and the temperature of the meat checked.

Sampling packaged raw beef. Different sampling procedures were used to detect the various types of organisms surviving in and on the meat. Separate counts were made in order to determine total aerobic, total anaerobic, aerobic spore, and anaerobic spore loads.

A swab technic was used in the first 2 series of trials to sample aerobic and anaerobic bacterial populations from (a) surface areas previously sliced at the packing plant and (b) native lean surfaces. Three sterile filter paper disks having 20 mm. diameter bores were placed at random on the meat in each case. Moist absorbent cotton swabs were used for sampling the three 3 sq. cm. areas and, after thoroughly wiping the exposed area, the cotton portion was aseptically transferred to a 6-oz. prescription bottle containing 100 ml. of sterile Ringer solution and refrigerated until agar pour plates or broth dilution tubes were set up. At the time the dilutions were to be made, the bottle was rapidly shaken 50 times.

In the third series, sections of flesh were excised by use of a sterile cork borer and scalpel. The size of surface area was the same as employed for swabbing but the flesh was cut to sufficient depth to give one gram of meat. When making cut sections it was necessary to estimate the depth of cut and underslice the tip of the cork borer with a sterile scalpel. Use of this procedure raised a question regarding the introduction of microorganisms from other areas. Also, in order to minimize contamination and handling, a sample of approximately one gram was excised and, after weighing, sufficient diluent was added to give the proper dilution. With practice, one gram amounts could be estimated within ±5% with ease, but the procedure had the disadvantage that surface areas among samples were not constant. The sample was held in the same manner as were the swabs. Before making dilutions for aerobic and anaerobic growth the meat was minced in Ringer solution for one minute in a sterile Waring blendor jar. (Owing to wide fluctuations in the flow of current in the laboratory, speed of blending was controlled by means of a variable voltage transformer set at 115 v.).

For the determination of aerobic spores the tubes were heated at 80° C. for 20 min. in order to eliminate vegetative cells. It was recognized that the heat treatment destroyed some of the labile spores and gave underestimates of the spore populations.

For anaerobic spore counts an approximately 100-g. portion of meat was collected from each of the 3 cuts of round in a sterile half-pint Mason jar. This meat was frozen at —18° C. and allowed to remain in the frozen state until anaerobic spore determinations were to be made. At that time the jar contents were permitted to thaw for 18-24 hours at 4.4° C. Then samples were weighed in sterile screw-cap Waring blendor jars (glass, small size) and sufficient 0.1% starch solution was added to fill the jars (540 ml.). In later trials blending assemblies were soldered to metal plates which could be inserted in the band portion of self-sealing screw-cap lids. This assembly permitted the use of Mason jars and, in addition, proved convenient and eliminated the necessity of transfer since the diluent could be added directly to the meat. It was necessary to cut the meat into small chunks before mixing in order that thorough mincing could be effected; the Waring blendor was run for 5 minutes to blend the sample.

Phenol red dextrose agar and phenol red dextrose broth modified by the addition of 0.5% yeast extract and 0.1% soluble starch were used to detect bacteria and bacterial spores growing aerobically. The following formulation was used in preparing these media:

Agar [a]	15 g.
Dextrose	10 g.
Proteose peptone No. 3	10 g.
Sodium chloride	5 g.
Yeast extract	5 g.
Beef extract	1 g.
Soluble starch	1 g.
Phenol red	0.025 g.
Distilled water	1000 ml.
pH 7.4	

[a] Agar was omitted in the formulation for phenol red dextrose broth.

Ordinarily, plate counts were used to determine the numbers of organisms in raw beef samplings while a Most Probable Numbers (M.P.N.) technic [McCrady *(8)*] was employed for estimating the amount of contamination in processed beef. Plates and tubes were incubated for 4 days at 30° C. before final counts were made. However, a preliminary check was made at the end

of 2 days of incubation in order to avoid the possibility that overgrowth by some of the organisms would cause the plates to be uncountable.

Incidence of cells and spores growing under anaerobic conditions was determined by plating the following medium in Krumwiede-Pratt plates sealed with a mixture of paraffin and mineral oil:

Proteose peptone No. 4[a]	20 g.
Agar	15 g.
Dextrose	5 g.
Yeast extract	5 g.
Sodium chloride	5 g.
Dibasic potassium phosphate	2.5 g.
Soluble starch	1.0 g.
Sodium thioglycollate	0.5 g.
Resazurin	0.001 g.
Distilled water	1000 ml.
pH 7.4	

[a] In the third series of tests casitone was used instead of proteose peptone No. 4. Several comparative recovery tests were made during the study using known loads of *Clostridium sp.* P. A. 3679 spores and, in each test, viable counts obtained were similar. Also, the number of spores which germinated to form colonies compared favorably with those growing in Brewer anaerobic agar (Difco) and anaerobic agar (BBL).

Usually, plate counts could be used to determine the total anaerobic population in raw beef. However, it was necessary to use an M. P. N. technic to determine the anaerobic count in processed beef. Anaerobic plates and tubes were incubated at 37° C. Readings were made at 2, 4, and 10 days.

An M. P. N. technic also was used to determine numbers of anaerobic spores. Anaerobic broth rather than agar was employed for the M. P. N. determinations. Aliquots representing one 25, five 5 and five 0.5 g. amounts of original sample were transferred to double strength broth. After inoculation, the medium was covered with a 2-3 mm. layer of sterile mineral oil and then heated to 80° C. and held at that temperature for 20 minutes in order to destroy vegetative cells. The heated tubes or jars were incubated for 10 days at 37° C. At the end of that time organoleptic tests (other than taste) were made to determine digestion, putrefactive odor, discoloration and gas production. Those samples which showed changes of these types served as the basis for reporting the probable contamination. Also, the contents of each tube were examined microscopically.

Canned raw beef. Rectangular chunks of meat were sliced in such manner that they could be forced into 300 × 308 tin cans and adopt the contour of the container. One can representative of each group was picked at random and was immediately frozen at —50° C. and remained in the frozen state until tested. At that time it was thawed in cold running water (15-20° C.) for about 30 min., then dried and, after sterilizing the outside, was opened using aseptic precautions. Two samples were taken from each can: an outer or peripheral portion and an inner or core section. The inside portion was obtained by use of a sterile stainless steel cylinder fitted with a rubber plunger. In sampling, approximately ½" of the top and bottom of the core were pooled with the remaining meat and collectively these constituted the peripheral part of the canned meat. Both portions were mixed with diluent in the same manner as that used for the packaged raw beef. Total counts as well as spore counts of organisms growing aerobically or anaerobically were made.

Canned thermal processed beef. Methods similar to those described for the canned raw beef samples were adopted. Sampling consisted of culturing the heat processed beef immediately after it had been thawed and mixed with diluent. One half of the meat in each can was divided into two parts and tested without further heating. The other half was heated to 80° C. and held at that temperature for 20 minutes before the meat was subcultured for aerobic and anaerobic growth. The additional heat treatment given the half of the processed canned meat used for spore determinations was considered necessary to free the product of surviving vegetative cells. This heating step was especially needed for those meats that received short-time or low-temperature retort conditions owing to the internal temperature lag at the center of the meat. The juice which collected by syneresis as a result of the heat treatment was drained into a sterile graduate. An indication of the contamination was derived by transferring portions of this juice into broth according to the M. P. N. method and, after incubation, making organoleptic tests similar to those used for core and peripheral portions.

TABLE 1

Retort temperature-processing time schedule

Row	Retort Temperature (° C.) Time in minutes at:					
	107.2°	117.2°	127.2°	137.2°	147.2°	157.2°
1	10	8	7	5	3	2
2	20	17	14	10	7	4
3	30	25	21	16	11	6
4	40	34	27	21	14	8
5	50	42	34	26	18	10
6	60	50	41	31	21	12
7	70	59	48	36	25	14
8	80	67	54	42	29	16
9	90	76	61	47	32	18
10	100	84	68	52	36	20
11	110	93	75	57	40	22
12	120	101	82	62	43	24

RESULTS AND DISCUSSION

The insulated corrugated paperboard cartons used for the first 2 series of samples permitted the maintenance of satisfactory storage conditions for the meat while enroute from the packing plant to the college laboratory. The commercial quilted canvas shipping containers employed for shipping the third series of matched beef sets did not keep the meat sufficiently well refrigerated during shipment. Meat used for the first series of experiments (12 shipments of 3 cuts each) was shipped during the fall months; meat for the second series was shipped during the winter. The third group of tests were made using beef shipped during late spring and early summer. Seven of the cuts shipped in fall and 9 of those sent during the winter months had subsurface temperatures exceeding 5° C. while 32 of the 36 cuts shipped during the third period were above that temperature. Also, the internal temperature of all but 13 in the last series was more than 4° C. while only one in the fall group and none of the winter series had central temperatures of more than 4° C.

Atmospheric conditions changed markedly during the 40-week trial period and, consequently, the various lots of beef were subjected to widely different climatic environments. Therefore it would be presumptuous to consider that the bacterial populations encountered in the first 2 series were smaller than in the third because of the type of shipping container used. It should be mentioned, however, that refrigerating conditions supplied by the commercial quilted canvas shipping bag would have been improved had insulation been provided in the bottom in addition to the ¾" board platform to which the quilted canvas was fastened.

Packaged raw beef. The total viable counts and the incidence of spores which would grow aerobically or anaerobically were determined for each of the cuts (see Table 2).

Total numbers of cells isolated from native lean (uncut) surfaces of inside and outside pieces of round were larger than from similar areas that had been sliced (cut-surface) at the packing plant just before the meat was shipped. While aerobic loads varied considerably among pieces of uncut round, usually there were from 10^5 to

TABLE 2

Incidence of total viable organisms and of spores growing aerobically or anaerobically in packaged raw beef

Kind of growth	Unit measured	Surface examined	Number of organisms		
			Smallest	Usual range	Largest
Total aerobic	No./sq. cm.	Uncut	100	100,000-10,000,000	20,000,000
		Cut	<100	10,000-1,000,000	3,300,000
	No./gram	Uncut	43,000	1,000,000-10,000,000	400,000,000
		Cut	17,000	10,000-1,000,000	68,000,000
Total anaerobic	No./sq. cm.	Uncut	100	1,000-100,000	300,000
		Cut	<100	1,000-100,000	100,000
	No./gram	Uncut	3,200	100,000-1,000,000	160,000,000
		Cut	3,200	100,000-1,000,000	70,000,000
Spores growing aerobically (facultative)	No./gram	Uncut	200	1,000-100,000	14,000,000
		Cut	900	1,000-100,000	1,900,000
Spores growing anaerobically (putrefactive)	No./100 g.		<0.06	0.7-6.0	140

10^7 bacteria per square cm. or from 10^6 to 10^7 per g. and, from sliced portions, 10^4 to 10^6 per sq. cm. or 10^5 to 10^6 per g. Two surface samplings of uncut round showed total counts of 10^7 per sq. cm.; ten had 10^7 or more cells per g. Two uncut surface areas had less than 10^2 cells per square cm. It should be pointed out that the surface flora on the native carcass tissue was permitted to develop from the time that the animal was skinned while organisms on sliced areas may not have been introduced until after the quarter was dissected.

Total counts obtained from cut-surface areas of pieces of knuckle were higher than from native surfaces; high counts ranged between 10^6 to 10^7 per g. for the former and 10^5 to 10^6 for the latter. A possible explanation for the reduced growth on the uncut surface might be that the network of white fibrous tissue which covers much of the knuckle musculature provides poorer nutrient qualities than do lean cut-surfaces. Consequently, microorganisms transferred to these new surfaces during the cutting operation outgrow those surviving on the native tissue during time of shipment. Haines *(5)* considered that much of the surface of the uncut beef carcass is covered with a layer of fat and connective tissue upon which little or no bacterial growth occurs during normal hanging. It should be noted, also, that in the study reported here, it was possible to select areas for swabbing or sectioning inside and outside rounds having little or no fat or connective tissue but that this was not the case for knuckle cuts.

In general, counts were larger when cut sections of tissue were analyzed than when equal areas of surface were swabbed. However, as was pointed out earlier, more favorable temperature conditions for bacterial reproduction and less adequate refrigeration were provided in the last series for the meat while enroute from the packing plant to the college laboratory. When both swab and cut sections from the same cut of meat were compared, differences in the number of cells recovered by the 2 methods were not pronounced; this did not substantiate the view that the larger populations which were found in the third series of samples were a direct reflection of the superiority of the cut-section method of sampling. Quite to the contrary, the swab method gave more duplicable results. In the cut sections there was some variation between the ratios of surface to total mass. This inconsistency may be of considerable importance. Moran *(9)* states that spoilage in stored, unfrozen beef is primarily a surface phenomenon and Moran and Smith *(10)* have shown that there was only a negligible increase in the number of organisms in the deep flesh of beef stored for two weeks at 5° C. That the surface contributes most of the flora was shown by Ayres, Ogilvy and Stewart *(2)* when they obtained comparable counts from cut sections and swab areas from equal amounts of surface of fresh chicken flesh. On the other hand, they point out that, late in the storage period, bacteria may penetrate the tissue. For this reason bacterial counts from samples of known weight may be justified even though they are tedious to make.

The load of cells growing anaerobically was consistently less than that of organisms growing in an atmospheric environment; the proportion of cells which would reproduce without free air represented 20% of the total flora.

A surprisingly large number of bacteria survived the 20-min. heating at 80° C. and were still capable of reproducing when grown under atmospheric conditions. This group, tentatively classified as aerobic (or facultative) spores, may play a significant role in the spoilage of canned meats and merit considerable study in the future.

Since the technic used for detecting putrefactive anaerobic spores differed from the other methods for determining viable organisms, results are not directly comparable. Ninety-nine separate samplings were made of packaged raw beef. In no case did the putrefactive anaerobic spore count exceed 1.4 spores per g.; in only 11 samples were there more than 0.06 spores per g.

Canned raw beef. The method used for sampling canned raw beef consisted of thoroughly mixing the entire outside or inner portion from each can with the diluent before subculturing aliquots rather than swabbing or sectioning a small amount. Therefore, a different surface-deep flesh relationship was represented than was reported for packaged raw beef.

In general, the count of cells and spores from the outside portions of cans of raw beef exceeded those found in the core. Also, the numbers of organisms growing aerobically were larger than of those growing anaerobically (see Table 3).

The average load of "aerobic" organisms from the outside portions ranged between 50,000 to 1,600,000 cells per g.; for the inner core sections 6,000 to 315,000 bacteria per g. were indicated. Contamination in the outer portions by organisms able to grow anaerobically usually varied from 3,200 to 100,000 while for the core

TABLE 3

Incidence of total viable organisms and of spores growing aerobically or anaerobically in canned raw beef

Kind of growth	Portion of canned meat examined	Numbers of organisms per gram		
		Smallest	Usual range	Largest
Total aerobic	Outside	2,000	50,000-1,600,000	36,000,000
	Core	100	6,000-115,000	4,500,000
Total anaerobic	Outside	100	3,200-100,000	25,000,000
	Core	10	1,000-50,000	850,000
Spores growing aerobically (facultative)	Outside	60	750-7,500	110,000
	Core	<10	300-3,000	6,000
Spores growing anaerobically (putrefactive)	Outside	<0.005	<0.005-0.030	0.13
	Core	<0.010	<0.012-0.070	0.12

the average load varied from 1,000 to 50,000 organisms per g.

There appeared to be a direct relationship between the total count of organisms growing aerobically with those multiplying without free air. From 81 samplings of peripheral and core portions in the last 2 runs, 70% of the determinations showed from 1 to 10 aerobes to each anaerobe; there was an over all ratio of aerobes to anaerobes of 6:1.

The number of heat-resistant cells or spores growing aerobically differed widely among samples. In some cases there were less than 10 organisms per g. while in others there were more than 100,000. It would not be advisable to consider that all of the surviving organisms were spores. Various workers *(1, 14)* have demonstrated the presence of species of *Microbacterium* in meats. Should certain heat resistant species or strains of this genus be represented, the organisms probably could have survived the heat treatment given. Also, it is quite possbile that heat tolerant micrococci, actinomycetes, and other vegetative cells can withstand 80° C. for 20 min. in a meat substrate. Yesair, Cameron and Bohrer *(16)* point out that the resistance of micrococci is enhanced in moist fat.

As in the packaged raw beef, spores of putrefactive anaerobes were present only in very small numbers. The highest number encountered in any sample was 0.13 per g. Less than 3% of the samples tested indicated spore loads exceeding 0.06 spores per g., while about 19% of the counts showed from 0.04 to 0.06 spores and 78% demonstrated the presence of less than 0.036 spores per g. In those trials using sufficient quantities of meat to detect spore loads in the region of 0.005 to 0.020, 18 samples gave reportable counts ranging from 0.005 to 0.011, while 55 samples still failed to indicate any viable spores by the M. P. N. method. Putrefactive anaerobic spores were recovered from 62% of outside and 21% of inside portions of the canned raw beef sampled in this study. The large difference between the perceritage of recoveries from these two portions may be attributed in part to the larger size of meat sample available for the testing of outer portions; usually the amount of meat comprising the outside part was approximately twice that of the core. Also, it is quite likely that the outer portion, being the more exposed, is more subject to contamination by these spores.

Thermal processed canned beef. The thermal processes which were required to destroy all spores from 100 g. of beef or to reduce total counts of organisms growing aerobically or anaerobically to less than 1 organism in 10 g. of meat are indicated in Table 4. No spores were recovered either from aerobic or anaerobic culture from beef that had received processes exceeding those recorded in the fourth or fifth row of retort time designations shown in Table 1. Also, cultures which survived the 20-min. heating period at 80° C. and subsequently grew under anaerobic conditions were not subcultured from meat that had been processed for times exceeding those shown in the third row of process time designations. On the other hand, total aerobic growth persisted in many cans of processed beef from which anaerobic spores could no longer be isolated.

Survival times for putrefactive anaerobic spores are represented in row IV and, to some extent, in row II of Table 4. No attempt was made to correlate these survival times with F_0 values for each of the processes; there were no viable spores although the F_0 was less than 0.01. It is probable that these cans contained no heat resistant spores. In view of the low numbers of putrefactive anaerobic spores that were encountered in fresh beef samples, these findings were not unexpected. It is not known whether this same condition prevails in the industry but, if it does, it should point out the reason that it is possible to successfully utilize a thermal process known to be inadequate to destroy spores of some of the more heat resistant anaerobes.

The role of the facultative aerobe in canned meats has received insufficient study. In this investigation the or-

TABLE 4

Survival times (in minutes) for organisms or spores in core (A) and outside portions (B) of canned beef processed in 300 x 308 cans

Incidence*	Kind of growth	Retort temperature (° C.)											
		107.2°		117.2°		127.2°		137.2°		147.2°		157.2°	
		A	B	A	B	A	B	A	B	A	B	A	B
Less than 1 organism/10 g. survived processing times longer than:	I. Total aerobic growth	50	60	50	50	41	34	31	26	14	21	12	10
	II. Total anaerobic growth	20	30	8	25	41	21	5	16	3	3	2	2
No spores survived processing times longer than:	III. Aerobic growth	40	10	34	34	34	21	10	16	7	18	4	6
	IV. Anaerobic growth†	20	30	25	8	21	7	10	10	11	3	2	2

* Results report survival time from the most resistant of three samplings.
† Based on M. P. N. for 100 g. of beef.

ganisms that were responsible for most of the spoilage either were facultative spores or heat resistant vegetative cells. This is shown by the results reported in rows I and III of Table 4.

It is significant that viable aerobic organisms were found in cans from which no putrefactive anaerobic spores were recovered. Although it is possible that heat tolerant micrococci, *Microbacterium*, and actinomycetes might be isolated from meat products, work in this laboratory and elsewhere indicates that members of the genus *Bacillus* are commonly found in cured perishable canned meat products. Their significance in beef is not known.

SUMMARY

Methods were developed for determining the incidence of total bacterial populations and of spores in fresh and thermal processed beef. Using these methods, studies were made to determine total aerobic and anaerobic loads and numbers of aerobic and anaerobic spores in fresh, canned and heat-processed beef. Populations were sampled at the time that the matched cuts were received from the plant, after the cuts had been handled and the meat placed in cans, and following various time-temperature processes.

Bacteria growing aerobically on the surface of fresh packaged beef often reached levels of 10^7 organisms per square cm. or $>10^7$ cells per g. but commonly were from 10^4-10^6 per sq. cm. or 10^5-10^7 per g. The usual load of these organisms in raw canned beef ranged between 10^3 to 10^6 per g.; counts from outside portions of the can ordinarily were larger than from samplings of core sections. In all cases the numbers of bacteria growing aerobically were larger than of those growing anaerobically. The ratio of aerobes to anaerobes was about 6:1.

A large number of bacteria survived a 20-min. heating period at 80° C. This group, tentatively classified as aerobic spores (facultative), may play a significant role in the spoilage of canned meats.

In this study putrefactive anaerobic spore loads were uniformly less than one spore per g. of beef. Also, the thermal processes found adequate for the destruction of these spores were insufficient to eliminate all spoilage forms. Results of this investigation indicate a possible reason that meat processors have been able to use thermal processes which are inadequate by theory. Also, the results point out a need for further study of the role of the facultative aerobe in canned meats.

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Juice Quality of Delicious Apples as Affected by Method of Fruit Handling

A. M. NEUBERT, G. H. CARTER, JACK L. HENRY, J. E. BREKKE, AND D. W. GRAHAM
U. S. Fruit and Vegetable Products Laboratory, Prosser, Washington[a]

AND

ARCHIE VAN DOREN AND RICHARD M. BULLOCK
Tree Fruit Experiment Station, Wenatchee, Washington[b]

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Wide differences were found in the quality of juices obtained from standard Delicious apples depending on their maturity, grade, and pre-processing treatment. Ripening after harvest was the most important factor in improving the juice quality of this variety. The flavor of juice improved with increased maturity at harvest but juices of good flavor could be produced from greener fruit by adequate post-harvest ripening. Juices from "Fancy and Extra Fancy" combination-grade Delicious were slightly higher in sugars, and were considered to have a slightly better flavor than those prepared from "C" grade fruit of the same harvest and treatment. This variety retained good juice quality through four months' cold storage.

The importance of good quality in apples used for juice is exemplified by a national survey of commercial juices wherein the quality of the apples used was considered one of the main factors affecting juice quality *(7)*. Good juice quality in apples implies sound fruit, properly matured and free from rot. Some workers consider bruised, wormy, or otherwise blemished fruit unsound for juice purposes. Opinions as to the best maturity for juice apples differ, and it may be that optimum maturity differs among varieties. Some consider that juice apples should be fully matured but not overripe; others believe the ideal condition to be slightly riper than is picked for fresh market but still too firm for best eating quality.

The effect of certain blemishes on the juice quality has been investigated, but data on the effect of maturity and fruit handling methods are limited. In a study of the effect of worm entrances, stings, and scab on the juice quality of several apple varieties, these blemishes were observed to increase viscosity, specific gravity, acidity, and tannin content *(4)*. In the same study juices from large apples were found to be higher in specific gravity and lower in acidity than juices from small apples; juices from red varieties showing 75% or more red surface color had higher specific gravities and viscosities and lower acid and tannin contents than juices from apples less red. The presence of cork, a physiological disease that seriously detracts from fruit quality in both appearance and texture, resulted in a smaller yield of juice, which was low in acid and high in sediment but did not contribute off-flavors in the McIntosh variety *(13)*.

This study reports the effect of maturity at harvest, ripening after harvest, and cold storage on the composition and quality of juice from standard Delicious apples —a variety of great importance in the Pacific Northwest. It is one of the main sources of juice fruit and processors incorporate a considerable portion in blends with more tart varieties. This study[c] also includes a comparison of the juice quality of "C" grade and "Fancy-Extra Fancy" combination grade. Most Delicious apples available to processors are those graded down because of pale color.

MATERIALS AND METHODS

Selection of fruit. Apples used in the 1951 study were from an orchard at the Tree Fruit Experiment Station in Wenatchee, Washington. Several 35-year-old trees of medium vigor and crop load were reserved for study and harvests were made from sectors of each tree carefully selected to give representative samples. Harvests made at 138, 151, and 167 days from full bloom comprised the first, second, and third harvests. Fruit from the first 2 harvests was graded on the basis of color into "C" grade and a combination "Fancy-Extra Fancy" grade. The third harvest was of fruit that was "C" grade in color at the time of the second harvest but which was allowed to remain on the tree for an additional 16 days. Fruit from this harvest, which was not segregated into grades, is referred to as "C" grade since it would have been "C" grade if harvested normally. Fruit of each harvest and grade was carefully composited to assure uniformity of samples.

The first harvest, made on September 13, was representative of early commercial harvest in the Wenatchee area and was comparable in maturity to the fruit available for juice processing during the early "cider" season. The size of fruit was 163 and larger, per packed box. The fruit was described as immature, tough, and starchy, with seeds not fully browned. The ground color was a light green, comparable to No. 2 on the Magness-Diehl color chart *(8)* and the flesh was slightly green and grainy. Average pressure test values for the "Fancy-Extra Fancy" and "C" grades were 20.9 and 20.7 lbs. respectively (Figure 2).

The second harvest, on September 25, was at a maturity considered prime for fresh market and presumably would be comparable in maturity to the bulk of standard Delicious available for juice processing. Size of fruit was about 120 per packed box. The fruit was described as mature, slightly tough, with brown seeds and some starch. The color was between No. 2 and No. 3 on the color chart with most fruits closer to No. 3. The flesh was free of green color. Average pressure test values for "Fancy-Extra Fancy" and "C" grades were 21.3 and 21.0 lbs. respectively (Figure 2).

[a] A Laboratory of the Bureau of Agricultural and Industrial Chemistry, Agricultural Research Administration, U. S. Department of Agriculture.

[b] Part of the Washington Agricultural Experiment Stations, State College of Washington, Pullman, Washington.

[c] The study was conducted during the 1950 and 1951 seasons with the exception that cold storage studies were not made in 1950. For the sake of brevity, only data from the 1951 season, which was more complete with respect to treatment and organoleptic evaluation, are presented. The same conclusions on the effect of grade, maturity, and post-harvest ripening on composition and juice flavor were arrived at in both seasons.

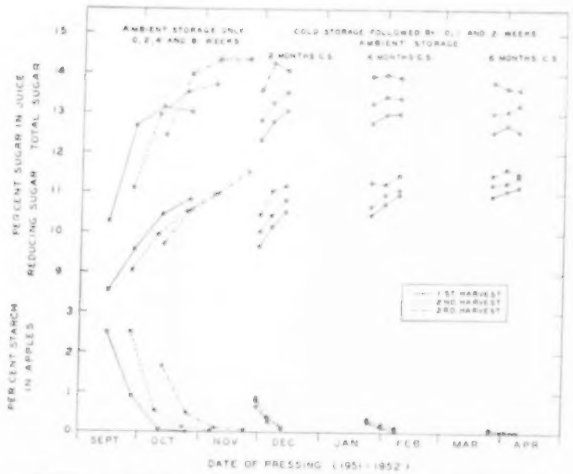

Figure 1. Changes in starch content of flesh and sugar content of juice from "C" grade Delicious apples during ripening on the tree and after ambient and cold storage.

The purpose of the third harvest was to determine whether color picking the main harvest to leave the "C" grade on the trees for later salvage as juice fruit would result in an improved juice quality. The practicability of color picking has been considered by various growers, because it would eliminate packing house handling costs on this lower-quality fruit. This harvest, which was made on October 11, consisted of fruit that was not considered excessively over-mature and showed very little water core. About half of the fruit had colored sufficiently to make the "Fancy-Extra Fancy" grade. The size range was 163 and larger per packed box and the average pressure test value was 19.2 lbs. (Figure 2).

Fruit handling methods. All samples were taken to Prosser, Washington, for processing. Eight boxes of each maturity and grade were used to study the effect of ripening at ambient temperature on juice quality. Weekly average temperatures in the processing laboratory where the fruit was held ranged from 73° F. (22.8° C.) in the early part of the fall to 51° F. (10.6° C.) in the late fall with short period extremes of 82° F. (27.8° C.) and 44° F. (6.7° C.). Relative humidity averaged 60% with short-period extremes of 80% and 32%. One 2-box lot of each

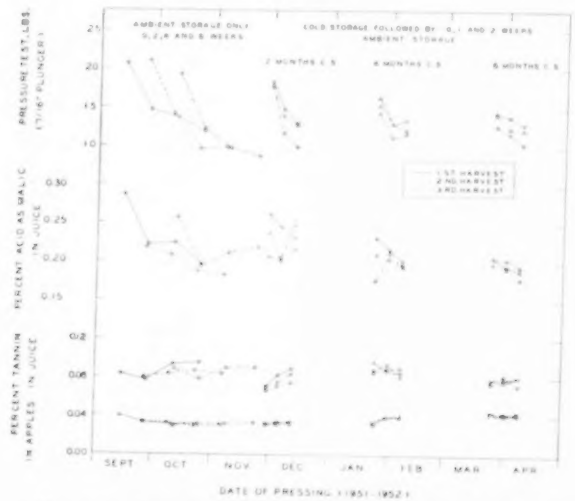

Figure 2. Changes in firmness and tannin content of flesh and acid and tannin content of juice from "C" grade Delicious apples during ripening on the tree and after ambient and cold storage.

grade and maturity was pressed the day after harvest and duplicate lots were pressed 2, 4, and 6 weeks after picking. This interval between pressings was selected because studies made in 1950 showed that changes occurring in one week were often not great enough to result in a noticeable change in juice quality. Although the riper lots were beginning to soften and become mealy after 6 weeks, no difficulty was experienced in pressing.

Eighteen boxes of each maturity and grade were placed in commercial cold storage at 31 to 32° F. (—0.6 to 0.0° C.) within 24 hours after harvest. Six boxes from each lot were removed from storage 2, 4, and 6 months after the second harvest. Two-box lots were pressed within 24 hours after removal from cold storage. Duplicate lots were pressed after ripening at ambient temperature in the processing laboratory for one and two weeks. The average temperature in the processing laboratory during this ripening was 67° F. (19.4° C.) and the average humidity was 46%.

Although the riper lots were becoming mealy after 4 and 6 months' storage followed by 2 weeks' ripening, no difficulty was experienced in pressing these lots. Scald was apparent on fruit from the first and second harvest of both grades after 4 months' storage and one week of ripening. This condition was only slight in the "Fancy-Extra Fancy" grade of the second harvest. Scald was apparent in both grades of first-harvest fruit and in "C" grade fruit from the second harvest one day after removal from six months of cold storage. The condition was progressively more severe after one and two weeks' ripening and also involved the "Fancy-Extra Fancy" fruit of the second harvest. In no case was the scald more than surface-deep and only a few fruits showed decay. No scald appeared on fruit of the third harvest even after 6 months of cold storage and 2 weeks of ripening.

Juice preparation. Two boxes of apples, about 70 lbs., were used in preparing each lot of juice. After removal of any decayed fruit and sampling for pressure test and chemical analysis, the apples were ground in a grater mill and the pulp pressed in a rack-and-cloth press. Aluminum racks, nylon press cloths, and a hydraulic press with a stainless-steel pan were used to reduce to a minimum the possibility of juice contamination. Special precautions, which included boiling and prolonged rinsing of racks and press cloths, were used in cleaning this equipment to avoid development of off-flavors. As a result only one sample had a detectable foreign flavor. The juice was placed in 5-gallon glass carboys and treated with a pectin-decomposing enzyme preparation to obtain clarification within 18 hours at 65 to 70° F. (18.3 to 21.1° C.). The clarified juice was filtered through duck cloth in a plate-and-frame press with filter aid. The filtered juice was flash pasteurized by passage through a block tin coil submerged in a boiling-water bath and filled into type-H, special enameled, 211 cylinder cans at about 190° F. (88° C.) to give a floating lid. The cans were immediately sealed, inverted for several seconds, and then water cooled. The cooled, dried cans were stored at 32 to 34° F. (0.0 to 1.1° C.).

Analytical methods. Twenty apples were selected at random from each 2-box lot for the determination of ground color, firmness, tannin, and starch. Firmness was measured with a Magness and Taylor *(9)* pressure tester using a 7/16-inch plunger. Measurements were made on the pared surface at three points around the circumference of each apple and the values averaged.

Wedge-shaped slices from stem to calyx were taken on opposite sides of each fruit for chemical analysis. Each wedge was subdivided to obtain a 100-gram sample for tannin analyses and the remainder was used for determination of starch.

Tannin was determined in the fruit ar' juice by the Rosenblatt and Peluso method *(12)*. The fr it was prepared for analysis by grinding 3 minutes in a blender with an equal weight of 95% ethyl alcohol. When applied to juice samples this method gave comparable values to those obtained by the permanganate titration method *(6)*, when a water blank was used and the permanganate solution was standardized against the same tannic acid preparation. Slightly lower values were obtained when activated-carbon-treated juice was used for a blank.

Starch was determined on pulp (prepared by thoroughly grinding apple wedges 3 minutes) by a modification of the Nielsen and Gleason iodometric method *(10)*. Five-gram portions of ground pulp were digested 10 minutes in 20 ml. of 8.0 *N*

perchloric acid with frequent stirring. This digest was transferred to a 100, 250, or 500 ml. volumetric flask, depending on the amount of starch expected, diluted to volume, mixed, and filtered through glass wool. An aliquot of filtrate was pipetted into a 100-ml. volumetric flask and 5 ml. water, 0.5 ml. of 10% potassium iodide, and 0.1 ml. of 0.01 *N* potassium iodate were added in succession. After mixing and standing 5 minutes the preparation was diluted to volume, mixed, and transmittancy determined with a photoelectric colorimeter using a 620 mμ filter. A blank was prepared in an identical manner except that 3 drops of 1 *N* sodium thiosulfate were added to remove the starch iodide color. The starch percentage was calculated from a standard curve obtained with a preparation of Delicious apple starch. Values obtained by this method on a number of Delicious apple samples, were in reasonably good agreement with those obtained by the much more difficult and time-consuming method of Pucher, Leavenworth, and Vickey *(11)*.

Total acidity was determined on the juice by titration to a pH of 8.1 with 0.1 *N* sodium hydroxide and calculated as percent malic acid *(1)*.

Reducing and total sugars were determined on the juice by means of the Lane Eynon method and calculated as percent invert *(2)*.

Taste tests. The triangle difference test was used to determine the comparative taste quality of the juices. Two ranking tests were also made to permit direct comparisons of a larger number of juices selected on the basis of the triangle tests. All taste tests were made in subdued red light to prevent detection of difference in color or turbidity. Samples were warmed to room temperature and covered to confine aroma and prevent visual inspection by the taster upon entering the tasting room. Tests were limited to one morning and one afternoon session per day with only one taster in the room at a time. The panel consisted of 16 judges and the average number of judges per test was 13.6 for 127 tests.

In making the triangle difference test the judges were asked to select the odd sample among three 50-ml. portions presented in coded beakers. The position of the odd sample with respect to the pair was randomized and the judges were asked not to note the code until the odd sample had been selected. Selection of an odd sample was required and judges were given an opportunity to indicate whether the selection was made on the basis of a more pronounced (a) aroma, (b) apple flavor, (c) sweetness, (d) tartness, or (e) astringency, and to make comments.

In making these tests it was observed that apple flavor is a much more effective index of differences than aroma. Dissipation of aromatic constituents, even from covered beakers, and the presence of this aroma in the atmosphere of the tasting room probably accounted for the judges' lack of acuity for aroma. When aroma was a factor in detecting differences, the judges usually associated it with a more pronounced apple flavor. For these reasons discussion of these qualities is usually limited to apple flavor. Similarly, discussion will be limited to sweetness since qualities of sweetness and tartness were more pronounced in opposite samples and chemical analysis showed differences in sweetness to be more likely.

In applying the triangle difference method to the 65 lots of juice involved in this study it was neither practical nor necessary to test all possible sample combinations. Many combinations could be eliminated as being very different by an inspection of the pre-processing history of the fruit and the analytical data. In most tests an effort was made to select those samples that might be expected to be similar. Taste tests on juices prepared from cold-storage fruit were limited to those from "C" grade fruit and to comparisons of juices from "C" and "Fancy-Extra Fancy" grades of the same treatment.

In making these tests a high correlation was observed between sweetness and apple flavor. Seventeen tests were therefore made on samples that had been adjusted to the same sugar and acid content, by the addition of sucrose and malic acid respectively, so the judges would have to rely mainly on aroma, apple flavor, astringency or differences other than sweetness or tartness to select the odd sample.

One ranking test was made with 9 juices from "C" grade fruit having the greatest possible difference in maturity at harvest and in post-harvest ripening. Duplicates from one treatment were included to give a total of 10 samples. In making this test the 16 judges were instructed to rank the juices in order of increasing aroma and apple flavor only. A similar ranking test was made by 15 judges to compare the effect on aroma and flavor of various cold storage treatments. Six different juices were used in this test.

RESULTS AND DISCUSSION

Comparison of "Fancy - Extra Fancy" and "C" grades. Pressure-test values of the fruit and data on composition of "C" grade fruit and resulting juices at harvest and after various ripening and cold-storage treatments are presented in Figures 1 and 2. Similar data on "Fancy-Extra Fancy" grade fruit of the first and second harvest are omitted for the sake of graphic clarity. The principal difference in composition between these grades was a consistently higher sugar content in juices from the "Fancy-Extra Fancy" fruit. In the 26 pairs of juice that differed only in grade of fruit used, those from the "Fancy-Extra Fancy" grade contained from 0.50 to 0.90% more total sugars and from 0.00 to 0.68% more reducing sugars. Corresponding average differences were 0.69 and 0.21%. There were no appreciable differences in pressure-test values or in the starch and tannin content of the fruit, and no consistent difference in acid or tannin content of the juice. Acid and tannin values obtained for juice were erratic in these studies and no conclusions as to differences in these constituents with the grade of fruit can be drawn. It will be noted that this method gave tannin values for juice in the order of about twice that for the fresh fruit.

In 14 triangle taste tests between juices differing only in grade of fruit used nine were significantly different ($p < 0.01$). Application of the statistical sign test *(3)* to comments by judges correctly identifying the odd samples showed that juice prepared from "Fancy-Extra Fancy" fruit had a significantly more pronounced apple flavor ($p < 0.01$) and was sweeter ($p < 0.01$), while that prepared from "C" grade fruit was more astringent ($p < 0.01$). Of particular interest is the fact that only one of the significantly different pairs was from fruit that had been ripened more than two weeks. Since differences in sweetness remained constant during ripening, post-harvest ripening appeared to minimize differences in apple flavor between these grades. Of three significantly different pairs, only one remained significantly different ($p < 0.01$) after adjustment to the same sugar and acid contents, indicating that the tasters were relying in part for their judgment on differences in sweetness.

Effect of ripening after harvest. A marked increase in total and reducing sugars and a corresponding loss of starch, particularly during the first 2 weeks, were the most important changes in composition during ripening after harvest (Figures 1 and 2). There was also a slight loss in acidity during ripening. The sharp loss in acidity in the fruit from the first and third harvest during the first two weeks of ripening was not observed in the 1950 study. There is no explanation for the low acid content of fruit from the second harvest at time of harvest but a similarly low acid content was found in juice from the comparable "Fancy-Extra Fancy" grade fruit of this harvest. The increase in sugars and loss of starch

were accompanied by considerable softening of the flesh as shown by a decrease in pressure-test values. There was no appreciable change in tannin values of apples and variations in tannin values of the juice do not appear to be related to the ripening process.

Post-harvest ripening caused a pronounced change in the flavor of the juice, which was greatest during the first 2 weeks. The taste panel was unanimous in selecting odd samples in all comparisons between juices prepared one day after harvest and those prepared after two weeks of ripening. Juices from fruit ripened 2 weeks were not only sweeter but judges were unanimous in indicating more apple flavor and less astringency. Most judges also indicated a more pronounced aroma after ripening. These important differences in flavor were observed even in juices prepared from fruit of the third harvest, which was quite ripe when picked. While apple flavor, aroma, and sweetness continued to increase as the fruit was ripened up to six weeks these changes were not as great as those occurring during the first 2 weeks and would not justify ripening this variety longer than 4 weeks.

It is apparent from these data that both firmness, as measured by pressure test, and starch content of the flesh would be suitable objective indexes of ripeness for the standard Delicious variety. Fruit within a firmness range from 10 to 14 pounds by the method used in this study would be at a ripeness suitable for good juice quality. This is comparable to the "Firm Ripe" to "Prime Eating" ripeness range for this variety as given by Haller *(5)*. Softer fruit within this range would produce juice of slightly more flavor and greater sweetness. Starch content for this range of ripeness was less than 1%.

Effect of maturity at harvest. There was a steady increase in total and reducing sugars of the fruit at harvest as maturity progressed from early commercial to overmature (Figure 1). Pressure-test values and starch content remained constant during the first and second harvest and dropped slightly in overmature fruit of the third harvest (Figures 1 and 2). Sharp drops in acid content of juice from both "Fancy-Extra Fancy" and "C" grades as the fruit progressed from early commercial to mature are not necessarily indicative of changes that might be expected because juice from the third, overmature harvest had considerably more acid than that of the second harvest. There was no appreciable change in the tannin content of the fruit or juice with increased maturity at harvest.

The taste panel was unanimous in detecting differences in flavor of juices from the 3 harvests, when pressed on the day after harvest, in all comparisons and in all cases juices from later harvests were considered to be sweeter and have a more pronounced apple flavor and aroma than those from earlier harvests. These differences remained significant ($p < 0.01$) even when the juices were adjusted to the same sugar and acid content. Juices from the first harvest were judged to be more astringent than those from later harvests, but there was no appreciable difference in astringency between juices from the second and third harvests. All juices prepared from unripened fruit were considered quite astringent, however, when compared with juices from ripened fruit.

The pronounced differences between juices from the 3 harvests, when pressed at time of harvest, were reduced considerably as the fruit was ripened in unrefrigerated storage. Differences between juices obtained from fruit of the first and third harvest were significant ($p < 0.01$), however, throughout the 6-week ripening period. Juices from the third harvest were considered to be sweeter and to have more apple flavor and aroma and less astringency in all cases. These taste differences were probably due mainly to differences in sugar content since adjustment to the same acid and sugar content reduced the number of comparisons that were significantly different ($p < 0.01$) from four to one.

Differences in the flavor of the 3 harvests could also be reduced and even reversed by an increase in ripening period of the less mature fruit. For example, there was no detectable difference between juice prepared from fruit of the second harvest after 4 weeks' ripening and that prepared from the third harvest after 2 weeks' ripening. Juice from first-harvest fruit after 6 weeks' ripening had a more pronounced apple flavor and aroma and was sweeter and less astringent that that prepared from the third harvest without ripening after harvest.

The trend and magnitude of the effects of maturity at harvest and post-harvest ripening on juice quality can be obtained from the data in Table 1. This table presents the results of a ranking test made with 9 juices from "C" grade fruit representative of the range encountered in this study.

TABLE 1

Ranking test of juices from "C" grade Delicious of nine harvest and ripening treatments

(Juices ranked 1 to 10 with rank of 10 given to juice with greatest apple flavor and aroma)

Fruit treatment	Rank [a]	Mean [b, c] Score
First harvest—no ripening	1.00	−1.540
Second harvest—no ripening	2.00	−1.000
Third harvest—no ripening	3.44	−0.544
First harvest—ripened 2 weeks	3.94	−0.135
Second harvest—ripened 2 weeks	6.38 [e]	+0.236
	6.50 [e]	+0.305
First harvest—ripened 6 weeks	6.69	+0.338
Second harvest—ripened 6 weeks	7.38	+0.576
Third harvest—ripened 6 weeks	7.50	+0.589
Third harvest—ripened 2 weeks	9.13	+1.175

[a] Mean value of rankings by 16 judges.

[b] Duplicate samples presented to judges.

[c] Calculated from ranking values by method outlined on page 50, "Statistical Tables for Biological, Agricultural, and Medical Research," R. A. Fisher and F. Yates, 1938, Oliver and Boyd, London.

[d] L. S. D. $0.01 = 0.44$; L. S. D. $0.05 = 0.33$. Analysis of variance calculated by method outlined on pages 214-226 "Statistical Methods," G. W. Snedecor, 4th Ed., 1946, Iowa State College Press, Ames.

Differences between juices from first, second, and third harvest fruit after 6 weeks' ripening were not significant in this ranking test, although differences between juices from first and third harvest fruit after 6 weeks' ripening were significant ($p < 0.01$) when tested by the more sensitive triangle method. It is interesting that the judges were almost unanimous in selecting juice from third-harvest fruit after 2 weeks' ripening as having the most apple flavor and aroma in this ranking test, while they found no significant differ-

ence between this juice and juice from third-harvest fruit after 6 weeks' ripening by the more sensitive triangle test. This can be explained only by the assumption that the position of the samples, which were identical for all judges, would influence judgments.

Effect of cold storage. There was a gradual loss of starch and an increase in reducing sugars throughout the 6 months of cold storage (Figure 1). Total sugars increased during the first 4 months and dropped slightly as storage was prolonged to 6 months. Pressure-test values became progressively lower during storage (Figure 2). There was a slight loss in acid content during storage of fruit from the first and the third harvest but low initial acid content obscured this change in fruit of the second harvest. There was no appreciable change in tannin content during storage. Ripening at ambient temperature after removal from up to 4 months cold storage resulted in further softening of the flesh, increases in total and reducing sugars, and loss of starch. After 6 months' cold storage the starch content was negligible and there was little change in sugar content during subsequent ripening.

The flavor changes caused in juice by ripening fruit for periods up to 2 weeks after removal from cold storage were similar to those found in post-harvest ripening of unstored fruit. Ripening after storage generally resulted in juice with a more pronounced apple flavor, aroma, and sweetness and less astringency. These differences were most pronounced in juices prepared from fruit stored 2 months, with 7 out of 8 tests having significant differences ($p < 0.01$) and least pronounced in juices prepared from fruit stored 6 months, with only 3 tests out of 8 being significant. Juices from riper fruit of the third harvest showed the least increase in flavor with post-storage ripening. These results indicate that desirable flavor changes occuring during post-harvest ripening also take place to a considerable degree during cold storage, so that post-storage ripening is less critical. Nevertheless there is a distinct advantage in ripening stored Delicious for a period of one to two weeks to obtain the greatest flavor and sweetness. Post-storage ripening also tended to dissipate foreign odors and flavors that may be absorbed during storage.

The problem of evaluating flavor of juices from cold-stored fruit proved difficult, because it was impossible to eliminate personal preference. Apple flavor and aroma, while pronounced, were different from those of juices prepared from fruit that had received no cold storage. In 20 triangle tests of juices prepared from unstored apples and apples stored 2, 4, and 6 months, significant differences ($p < 0.01$) were observed in 11. Juices for these comparisons were in most cases selected for comparable sugar and acid content and were of the same harvest and grade for each test. The flavor of juices prepared from cold-stored fruit, while different, was quite acceptable. Majority preference was indicated for juice prepared from stored fruit or from fruit receiving the longer storage treatment in 9 tests and for juice from unstored fruit or fruit receiving the shorter storage treatment in 4 tests.

Results of the triangle taste tests were confirmed by those of the ranking test presented in Table 2. In this test the confusion of the judges as to what constituted apple flavor and aroma was quite evident. For example, juice prepared from second-harvest fruit after 6 months' cold storage followed by 2 weeks ripening was given a high rank of 5 or 6 by 4 judges and a bottom rank of 1 or 2 by 6 judges. Because of the problem of evaluating apple flavor and aroma in these samples the results are not as conclusive as those of the ranking test shown in Table 1. It is evident, however, that cold storage of Delicious under proper conditions for periods up to at least 4 months is not detrimental to their juice quality. Firmness or starch content would be equally useful in determining suitable ripeness for pressing cold-stored fruit as for unstored fruit.

TABLE 2

Ranking test of juices from "C" grade Delicious of six harvest, cold storage, and ripening treatments

(Juices ranked from 1 to 6 with 6 given to juice with greatest apple flavor and aroma)

Fruit treatment	Rank [b]	Mean [c, d] Score
First harvest—ripened 4 weeks	2.13	−0.665
Second harvest—6 months' cold storage, ripened 2 weeks	3.07	−0.240
Third harvest—ripened 4 weeks	3.60	+0.073
Second harvest—ripened 4 weeks	3.80	+0.159
Second harvest—4 months' cold storage, ripened 2 weeks	3.87	+0.152
Second harvest—2 months' cold storage, ripened 2 weeks	4.54	+0.521

[b] Mean value of ranking by 15 judges.

[c] Calculated from ranking values by method outlined on page 50 "Statistical Tables for Biological, Agricultural, and Medical Research," R. A. Fisher and F. Yates, 1938, Oliver and Boyd, London.

[d] L. S. D. $0.01 = 0.905$; L. S. D. $0.05 = 0.653$. Analysis of variance calculated by method outlined on pages 214-226, "Statistical Methods," G. N. Snedecor, 4th Ed., 1946, Iowa State College Press, Ames.

SUMMARY AND CONCLUSIONS

The effects of grade, maturity at harvest, post-harvest ripening, and cold storage on composition and quality of juice from standard Delicious apples were investigated.

Post-harvest ripening was the most important factor in determining the composition and flavor of juice obtained from this variety. Juices pressed shortly after harvest were lacking in apple flavor and were astringent. Post-harvest ripening was accompanied by a marked increase in sugars and loss of starch. This was true even for fruit that had reached full maturity before picking. Ripening for periods of at least 2 weeks after harvest was essential to the development of apple flavor and aroma, and flavor continued to increase as the ripening period was extended to 6 weeks, particularly in greener fruit.

Increased maturity at harvest, within the commercial range, resulted in increased apple flavor and sweetness and decreased astringency in the juice. While this effect was reduced as the fruit ripened during either unrefrigerated or cold storage, greater maturity at harvest was advantageous to juice quality.

The flavor of juices from fruit held in cold storage for periods up to 4 months, while different, was equally as acceptable as that of juices prepared from unstored fruit. Apples ripened slowly during cold storage, so that optimum flavor and sweetness were developed in this stored fruit after shorter periods of ripening than

with the unstored fruit. Storage scald, when confined to the skin, was not detrimental to juice quality of the Delicious variety.

Juices from "Fancy" and "Extra Fancy" combination grade apples were slightly sweeter and had slightly more flavor than juices from "C" grade fruit of comparable maturity and treatment. These differences were minor, however, and tended to disappear with post-harvest ripening.

Firmness as measured by pressure test and starch content of the flesh were suitable objective indexes of optimum ripeness for pressing.

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Quality and Yield of Filbert Nutmeats as Affected by Time of Insect Attack and Use of Certain Insecticides

GLADYS L. GILPIN and ELSIE H. DAWSON
Bureau of Human Nutrition and Home Economics
AND
E. H. SIEGLER
Bureau of Entomology and Plant Quarantine, Agricultural Research Administration, United States Department of Agriculture

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Studies on filbert nutmeats were carried out to determine whether quality and yield of nuts could be correlated with time of insect attack, studied by enclosing nut clusters in bags at intervals during the growing period, or by insecticide treatment with DDT, BHC, or parathion to control insect infestation.

Occurrence of bitter flavors and shriveled nuts in filberts has become a serious problem in some filbert orchards. The cause of bitterness and shriveling has not been definitely established but insect damage is suspected. To obtain information on possible relationships between insect attack and flavor and yield of nutmeats, cooperative studies were carried out by the two organizations identified above.[a] This report presents the results of 2 different approaches to the problem of bitterness in filberts and low yield of choice nutmeats. In one approach, the time of insect infestation was investigated and related to the quality and yield of filbert nutmeats. In the other, the effect of certain insecticides sprayed on filbert trees on quality and yield of nutmeats was studied.

[a] Samples were provided by the Division of Fruit Insect Investigations, Bureau of Entomology and Plant Quarantine; quality studies on the filberts were conducted by the Bureau of Human Nutrition and Home Economics.

METHODS

In the first study an attempt was made to get information as to the time when the insects were most active in attacking the nuts by enclosing nut clusters within bags at 10 one-week intervals, beginning the latter part of June, 1950. All of the nuts from clusters bagged at one time were included in one lot, making 10 sample lots for this study. This experiment was carried out in an orchard at Scientists' Cliffs, Maryland, where many of the nuts from previous harvests had been unpalatable. Surveys were made in this orchard from time to time during the growing season to determine the species of insects that might be concerned in this study.

The other study on the effect of insecticidal treatments for the control of sucking insects that may cause kernel spot and result in bitter flavor in filberts was started in 1950 as a small-scale field experiment in an orchard at Stewartsville, Virginia. The following treatments were applied on June 14, July 1, and July 18 for comparison with untreated trees:

Plot no.	Insecticide formulation	Concentration of spray (lb. per 100 gal. water)
I	DDT—50% wettable powder	3
II	Benzene hexachloride—(BHC) 10% gamma isomer wettable powder	3
III	Parathion—25% wettable powder	1½
IV	Check—untreated	0

Three trees were included in each treatment and in the untreated control, and the total harvest from each tree was used as one sample in the quality studies. The filberts were harvested at maturity in September, stored at room temperature until October, then were cracked and the nutmeats stored in sealed glass jars under refrigeration for the brief duration of the quality studies.

Nutmeats from each sample were sorted into two classes according to external appearance: (a) Choice, well-formed nutmeats, appearing free from insect injury, and (b) inedible-appearing, partially developed, shriveled, insect-infested, or moldy nutmeats. Nuts which had no kernel or an undeveloped kernel that filled less than one-fourth of the capacity of the shell were termed "blank" nuts. Yield data were calculated on the basis of total number of nuts in the sample and also on the basis of total weight of the sample. Kernels broken when removing the shells were included in yield data but were not rated for palatability.

The choice filberts from each treatment were placed in cellophane bags with 5 nuts in each bag. The nuts were tasted by a panel of 5 persons, selected for their ability to recognize bitter flavors in test solutions and in known samples of bitter or non-bitter nuts. Each panel member tasted the 5 nuts from one bag at one tasting session; there were 4 sessions each day. Nuts were rated as having sweet, natural flavor or slight, moderate, or very bitter flavor. Panel members also were asked to name any other flavor present. They were instructed to rinse the mouth with water and to allow a few minutes to elapse between sampling any 2 nuts to avoid carry-over of flavors. Since the number of nuts in the different samples varied, results are presented as percentages of the total number of nuts in samples from each treatment.

RESULTS

Quality and yield of filberts in relation to time of insect attack. Palatability studies showed that the percentage of judgments rating nuts as sweet, natural flavored was higher, and the incidence of slightly bitter, moderately bitter, very bitter, spoiled, and rancid nuts was lower for the samples of nuts bagged in June and July than for those bagged in August, 1950 (Table 1). These results indicate that insect infestation occurred during June and July.

Yield data on filberts from nut clusters bagged at intervals during a 2-month period also give some indication as to time of insect attack. Yield in number of choice nutmeats (Table 2) was higher when nuts were bagged during the first part of the season than in the last part. Considering yield in terms of weight of choice nutmeats (Table 3), the samples bagged from June 29 to July 18 were above the average for all samples, those after July 18 were below the average. The sample bagged on July 25 showed some decrease in yield over the previously bagged ones and may indicate that insect attack occurred sometime before that date but after July 18.

TABLE 2

Yield of filberts from clusters bagged at intervals during a two-month period to prevent insect infestation, calculated on the basis of number of nuts

Date nuts were bagged	No. of nuts in sample	Choice nutmeats	Inedible nutmeats [b]	Blank nuts
		%	%	%
June 29	40	58	22	20
July 5	55	80	7	13
July 10	58	62	10	28
July 18	96	67	14	19
July 25	84	53	30	17
August 1	67	27	24	49
August 8	48	42	8	50
August 15	54	33	17	50
August 24	58	45	15	40
August 29	68	46	31	23
Total or average	628	51	18	31

[b] Includes partially developed, shriveled, insect-infested, and moldy nutmeats.

TABLE 3

Yield of filberts from clusters bagged at intervals during a two-month period to prevent insect infestation, calculated on the basis of weight of the nuts

Date nuts were bagged	Weight of sample	Choice nutmeats	Shells, blank and inedible nuts [c]
	g.	%	%
June 29	87	29	71
July 5	91	40	60
July 10	125	30	70
July 18	192	32	68
July 25	291	17	83
August 1	124	16	84
August 8	109	23	77
August 15	113	17	83
August 24	112	22	78
August 29	130	23	77
Total or average	1375	25	75

[c] Inedible nuts were partially developed, shriveled, insect-infested, or moldy.

TABLE 1

Flavor ratings for choice filberts from nut clusters bagged at intervals during a two-month period to prevent insect infestation

Date nuts were bagged	No. of nuts rated	Judgments rating flavor of nuts as—					
		Sweet natural	Slightly bitter	Moderately bitter	Very bitter	Spoiled	Rancid
		%	%	%	%	%	%
June 29	20	65	35	0	0	0	0
July 5	39	69	18	10	3	0	0
July 10	36	72	22	3	3	0	0
July 18	64	61	31	5	0	0	3
July 25	45	72	22	2	2	2	0
August 1	17	53	35	6	6	0	0
August 8	19	47	53	0	0	0	0
August 15	18	44	39	11	0	0	6
August 24	26	38	23	19	12	8	0
August 29	31	39	38	10	10	3	0
Total or average	315	56	31	7	4	1	1

TABLE 4

Flavor ratings for choice filberts from unsprayed trees and from trees sprayed with BHC, DDT, or parathion

Treatment	No. of nuts judged	Judgments rating flavor of nuts as					
		Sweet natural	Slightly bitter	Moderately bitter	Very bitter	Spoiled	Tasteless
		%	%	%	%	%	%
Unsprayed	240	60	33	5	1	0	1
BHC spray	246	48	35	13	3.5	0.5	0
DDT spray	185	59	33	6	2	0	0
Parathion spray	296	59	30	8	2	0.5	0.5

Incidence of inedible-appearing nuts, excluding blank nuts, was erratic; more blank nuts were found among samples bagged after August 1 than before. Shells and inedible nuts varied from 60 to 84% of the total weight of the nuts with an average of 75% for all lots. The weight of shells and inedible nuts in samples bagged before July 25 was lower than the average; after July 25, more than the average.

During the period in which nut clusters were bagged, the following species of sucking insects were handpicked from the trees: *Acanthocephala terminalis* (Dallas), *Leptoglossus oppositus* (Say), *Aerosternum hilare* (Say), *Euschistus tristigmus* (Say), *Brochymena sp.*, probably, *quadripustalatus* (F).

Quality and yield of filberts in relation to insecticide treatments. Flavor ratings for the choice nutmeats from both sprayed and unsprayed trees are given in Table 4. The percentage of choice nutmeats that had natural, sweet flavor was approximately the same from unsprayed trees as from those sprayed with DDT or parathion. The proportion of good-flavored nuts was about 12% lower for nuts from the trees sprayed with benzene hexachloride (BHC) than for the others. This difference is of questionable significance because the natural, sweet flavored nuts in samples from two of the three trees given the same treatment varied as much as 24%. The percentages of slightly bitter nuts from sprayed and unsprayed trees were almost the same. The percentage of moderately bitter and very bitter nuts from trees sprayed with BHC was larger than for any other sample. There were a few cases where perfect-appearing nuts from the BHC and parathion treatments were spoiled on the inside and a few nuts which the panel members described as being tasteless. It is questionable, however, whether the difference in bitterness of filberts from the unsprayed trees and those sprayed with DDT, BHC, or parathion were large enough to be of practical importance.

Yield data on filberts from unsprayed trees and from trees sprayed with BHC, DDT, or parathion are given in Tables 5 and 6. Averages for all trees given the same treatment indicated that yield of choice nutmeats was increased by all of the sprays used. Only 60% of the number of nuts from unsprayed trees contained choice nutmeats while sprayed trees yielded between 70 and 85% (Table 5). The percentage of blank nuts was about the same for all treatments.

By weight, nuts from unsprayed trees averaged 29% choice nutmeats, nuts from trees sprayed with BHC, 35%, with DDT or parathion, 38% (Table 6). Inedible nutmeats, including shriveled, moldy, and insect-infested nuts, made up 11% of the total weight of the unsprayed samples, whereas only 2 to 5% inedible nutmeats were found in sprayed samples. Spraying decreased somewhat the combined weight of shells and inedible nuts which averaged from 62 to 65% for samples given the various spray treatments as compared with an average of 71% for nuts from unsprayed trees.

TABLE 5

Yield of filberts from unsprayed trees and from trees sprayed with BHC, DDT, or parathion, based on number of nuts

Treatment	No. of nuts in sample	Choice nutmeats	Inedible nutmeats[a]	Blank nuts
		%	%	%
Unsprayed	401	60	30	10
BHC spray	355	71	17	12
DDT spray	246	77	15	8
Parathion spray	371	84	8	8

[a] Includes partially developed, shriveled, insect-infested, and moldy nutmeats.

TABLE 6

Yield of filberts from unsprayed trees and from trees sprayed with BHC, DDT, or parathion, based on weight of nuts

Treatment	Weight of sample	Choice nutmeats	Inedible nutmeats*	Shells	Shells and inedible nuts
	g.	%	%	%	%
Unsprayed	951	29	11	60	71
BHC spray	913	35	5	60	65
DDT spray	636	38	5	57	62
Parathion spray	1031	38	2	60	62

* Includes partially developed, shriveled, insect-infested, and moldy nutmeats.

SUMMARY

When filberts were bagged at intervals during the growing period to prevent insect infestation, quality and yield of nutmeats were better from the nuts bagged in June or July than from samples bagged in August, 1950, indicating that insect attack occurred early in the growing season.

The incidence of bitter flavor in filberts showed no general relationship to control of insect infestation by spraying with BHC, DDT, or parathion. However, these insecticides were effective in increasing the percentage of nuts containing nutmeats rated as choice on the basis of appearance and consequently increased the total yield of sweet, natural flavored nutmeats. The greatest increase in choice nutmeats resulted from use of parathion, next from DDT, and the least from use of BHC. The sprays decreased somewhat the amount of shriveled, moldy, and insect-infested nuts.

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Studies on the Recovery of Essence from Florida Orange Juices[a]

DONALD A. MORGAN AND M. K. VELDHUIS
U. S. Citrus Products Station,[b] Winter Haven, Florida
AND
R. K. ESKEW AND G. W. M. PHILLIPS
Eastern Regional Research Laboratory,[b] Philadelphia, Pa.

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A system for recovering water-soluble essences of orange juice under vacuum at temperatures of 110-115° F. (43.3-46.1° C.) is described. The orange juice is not noticeably deteriorated at this processing temperature. A relationship is shown between aroma of the essence and peel oil content. The use of water-soluble essence enhanced the floral character of freshly prepared concentrate and reconstituted product.

In the process of concentration of citrus juices, certain water-soluble odorous constituents which are characteristic of the fresh juice are normally volatilized along with the water. The concentrate when reconstituted, therefore, lacks natural aroma. Methods of restoring this lost flavor are of interest to food technologists.

In any study of the flavor of citrus juices, peel oils need also to be considered, since they are known to contribute to the characteristic aromas. Cold pressed orange peel oil, for example, has been used to impart an orange flavor to confectionery and beverages, including orange concentrate *(8, 15)*.

Principal objective of the present work was to determine the effectiveness of water-soluble, steam-volatile constituents in enhancing the flavor of the orange concentrate. The investigation also comprises the adaptation and improvement of equipment developed by other workers *(4, 5)* for the recovery of volatile constituents from fruit juices, and an evaluation of the odor strength of the essence recovered and its use for restoring odor to concentrate. The term essence as used in this paper refers specifically to the water layer. It is realized that odorous materials present will be partitioned between the aqueous phase and a possible oil phase predominately *d-limonene*.

PREVIOUS WORK

Chemical composition. Hall and Wilson *(7)* studied the chemical composition of the volatile water-soluble, aromatic constituents which they concentrated from orange juice by successive vacuum distillations. Oils which separated were systematically discarded. The constituents found would also be present in essence recovered in the current study because of basic similarity in the recovery processes. Ethyl alcohol, acetone, acetaldehyde, and formic acid were the principal constituents, with ethyl alcohol being the most abundant. An olefinic alcohol, an amyl alcohol, phenylethyl alcohol, and esters of formic, acetic, and caprylic acids were also present; some terpenes were indicated.

Poore in 1932 *(14)* investigated the composition of California Valencia and Washington Navel orange oil and reported the presence of *d*-limonene, decylic aldehyde, formic acid, acetic acid, capric acid, caprylic acid, octyl alcohol, and an olefine alcohol, $C_{10}H_{18}O$, closely related to linalool. A trace of linalool was also indicated. Nelson and Mottern *(13)* found citral in Florida Valencia orange oil. In the preparation of coldpressed oils such as these, an emulsion of oil in water or juice is obtained and the oil separated by centrifuging. Some of the peel oil constituents are water-soluble and steam-volatile. These constituents would be recovered as essence from the orange juice or water in which they are dissolved.

Rice, Keller, and Beavens *(15)* have studied the aromatic constituents in California orange juice. They rectified the water condensate obtained during concentration of the juice and used it to fortify the flavor and aroma of the concentrates produced. Upon storage of these concentrates, "apricot-like" flavors were reported in the reconstituted juices.

After extracting the water condensate with ether, only formaldehyde, methyl alcohol, acetaldehyde, ethyl alcohol, acetone, furfural, and an unidentified acetate ester were found. From 0.004 to 0.006% recoverable oil was found in juices which had been prepared from carefully peeled fruit. They concluded that the volatile flavor and aroma were primarily associated with the volatile oils and that the volatile flavor and aroma lost during evaporation could be restored by adding carefully selected coldpressed peel oil or orange puree.

Hydrogen sulfide was identified as one of the volatile constituents of orange juice by Kirchner, Rice, Miller, and Keller *(9)*. Hydrogen sulfide would not be recovered in essence recovery under vacuum unless liquid air traps or some similar system were used.

Methods of restoring flavor. MacDowell, Moore, and Atkins *(10)* investigated the addition of fresh juice as a method of restoring flavor to orange concentrate. This method, known as the "cutback process," is now widely used. Some of the basic features of this method are incorporated in a patent assigned to the Secretary of Agriculture *(10)*.

Kaufman and Campbell *(8)* have investigated the effect of variation in source of orange flavor and aroma on the flavor and aroma of reconstituted orange concentrate. They used the first condensate from atmospheric concentration of orange juice, a rectified condensate from vacuum concentration of orange juice, and various orange peel oils. They observed an "apricot- or strawberry-like" flavor after storage of frozen orange concentrates fortified with rectified condensate.

Methods of recovery. The method of recovering volatile aromatic constituents that has been singularly successful has been that developed at the Eastern Regional Research Laboratory, for use with apple juice *(6, 11)* and with grape juice *(5)*. Other developments in this method have been accomplished at the Western Regional Research Laboratory *(16)*. In these processes, the general procedure has been to heat the juice rapidly to the boiling point and then vaporize about 10% in a single pass through a tubular heat exchanger. Then, by fractionating the vapors in a packed column, a concentrated essence was obtained of about one-hundredth the volume of the original juice. The comparatively short heating period did not materially affect the flavor of these juices and excellent, full-flavored concentrates were prepared.

An effort was made at the U. S. Citrus Products Station, at Winter Haven, Florida, to adapt the essence recovery equipment

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[b] One of the Laboratories of the Bureau of Agricultural and Industrial Chemistry, Agricultural Research Administration, U. S. Department of Agriculture.

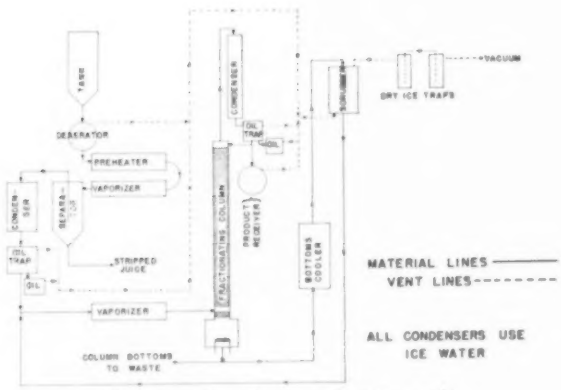

Figure 1. Flow diagram of essence unit.

originally developed at the Eastern Regional Research Laboratory to the preparation of full-flavored concentrated orange juice. The adaptation consisted of an oil decanter to remove the water-insoluble oils. It was found that the heating to boiling at atmospheric pressure materially affected the flavor of the stripped juice. However, an aromatic water-soluble essence, floral in character, was obtained. When stored in bottles at 35° F. (1.7° C.) for 5 years, these essences of 100- to 150-fold strength did not change materially.

A further adaptation was made at the Fruit and Vegetable Products Laboratory (USDA) at Weslaco, Texas. This adaptation consisted of cooling the heated juice rapidly by evaporation into a vacuum. Using this method, an aroma of grapefruit and Meyer lemons was obtained without serious deterioration of the juice. Each citrus variety yielded a distinctive essence.

EXPERIMENTAL

Equipment and operation. In the present investigation, equipment was used in which the juice was not heated above 115° F. (46.1° C.) and the heating, evaporation, and essence recovery were conducted entirely under vacuum. Figure 1 is a flow sheet of the method used in recovering essence in these experiments. Orange juice was pumped through a small diameter, jacketed tube where it was heated to about 115° F. (46.1° C.), and then about 10% of the liquid was vaporized in a second, larger jacketed tube. The liquid and vapors were immediately separated, the liquid being cooled to about 80° F. (26.7° C.) by flashing into a suitable vacuum after passing through a manually operated liquid seal. The vapors were condensed and any oil globules separated in a decanter. This condensate was again stripped by vaporizing about 30% of the liquid in another tubular heat-exchanger. These vapors led into the fractionating column where the aromatic materials were concentrated. The fractionating column had a stripping section between the vapor inlet and the reboiler of about one-tenth the length of the column. The vapors from the top of the column were condensed with a surface condenser and any oil globules again removed with a decanter. A portion of this condensate was removed continually as 100- to 150-fold essence and the remainder returned to the top of the column as reflux. Stripped column bottoms were removed substantially free of aromatic materials. All vent lines led to a manifold where the exit gas was scrubbed with refrigerated column bottoms. The enriched scrubbing liquid was mixed with condensate passing to the second vaporizer and so recycled. All gases and vapors passing through the scrubber were led through dry ice traps to remove additional vapors. Ice water was used in all condensers and coolers and hot (150° F. or 65.6° C.) water in all heaters and vaporizers. During operation, observations of rate of flow of juice, extent of vaporization in each of the 2 vaporizers, temperatures of vaporization, and pressures were recorded. The concentrated essence condensate in the dry ice traps, and column bottoms were collected separately and measured.

Ten gallons of fresh juice was the usual amount used for each run. The feed rate of fresh juice was maintained at about 8 gallons per hour and the essence volume at about 0.7% of the raw juice. A known volume of raw juice was used and stripped juice was determined by difference.

When concentrates were to be prepared for flavor evaluation, the stripped juice passed directly into a falling film evaporator and was concentrated to the desired solids content at 70° F. (21.1° C.).

Materials and preparation. In one series of experiments, juices of different peel oil contents were obtained from a single lot of Pineapple oranges. Included were: whole fruit puree, machine-reamed, hand-reamed and juice free of peel oil. The whole fruit puree *(1, 2)* was prepared by cutting fruit in quarters and passing through a tapered screw press with 0.027 inch perforations. Pulp, peel, and seeds were discarded. The machine-reamed juice was prepared on a rotary juice extractor of commercial design and the hand-reamed juice by cutting the fruit in halves and reaming by hand with an electric burring reamer. The juice free of peel oil was prepared by the method suggested by Blair and co-workers *(3)* in which the fruit was first plumped by immersing in water at 180° F. (82.2° C.) for 5 minutes, cooled, peeled by hand, the peeled fruit treated with permanganate to remove traces of peel oil, and with sodium bisulfite to remove permanganate stains. The fruit was then washed and the juice was extracted from the whole fruit in a tapered screw press with a 0.027 inch screen. Each of the stripped juices was passed through the essence unit a second time, the essence and trap condensates from each pass being collected as separate fractions.

A coldpressed peel oil emulsion also was used in the equipment. Emulsions of a good grade of orange peel oil were prepared at levels of 0.01% and 0.05%. The emulsions were passed through the equipment only once and the essence and trap samples collected.

Analytical methods and data. Recoverable oil contents, soluble solids, and total acid contents were determined on all fresh juices and recoverable oil again on the stripped juice.

The raw juice had a soluble solids content of 11.6° Brix and an acid of 0.90%. The range of recoverable oil was from 0.88% to 0.004%. The values of recoverable oil for machine-reamed and hand-reamed juices are considered normal for commercial operation. Grade A canned juice specifications call for not more than 0.03% recoverable oil and around 0.01% is generally considered satisfactory for reconstituted frozen concentrates. Values above 0.070% would be exceptional with current juice extraction procedures. The puree was included as an extreme.

The recoverable oil value in the juice free of peel oil was 0.004%. This oil presumably came from the fruit pulp since the peel had been carefully removed. The value of recoverable oil in juice prepared in this manner appears to vary widely with the maturity and perhaps also with the variety. Similar results were obtained by Rice, Keller and Beavens *(15)*. In other work, with midseason Valencia oranges, this method yielded a juice of 0.0012% recoverable oil, and with late season Valencia oranges, recoverable oil value of 0.0006%.

EVALUATION

Methods. Attempts were first made to evaluate the strengths of the various essences by chemical methods. The permanganate oxidation procedure used in determining Oxygen Consumed values for sewage and modifications were tried. It was found that the values obtained were due largely to ethyl alcohol in the essence. Since alcohol is considered a minor factor in orange aroma and is not exclusively related to odor strength, the method was abandoned.

Approximations of the potencies of the various essences, trap condensates, peel oil emulsions, and orange juice were made by the odor threshold method *(12)*. All the essence fractions were first reduced by dilution with distilled water until they occupied the same volume as the juice from which they came. The essences were then diluted in steps in clean glass stoppered bottles until a difference in odor could no longer be detected between the sample and distilled water. Steps in dilution used were: 10, 20, 40, 100, 125, 200, 333, 500, 1000, 1250, 2000, 3333, and 5000 to 1. Samples were always vigorously shaken before evaluation by smelling. The last dilution at which odor could

be detected (expressed as parts of solution per part of essence) was called the threshold value. A panel of 8 to 12 judges was used. Generally, 4 samples were judged at one time. However, a larger group could be judged since at the high dilutions used, the nose recovers from fatigue rapidly. Comparisons were made only between the 4 samples or less examined as a group. The threshold values obtained by the individual members of the panel were averaged for each sample. The sample with the greatest threshold value (the strongest odor) was arbitrarily assigned a value of 1.0 and the others in the group rated according to this value.

Comparisons made. Comparisons were made between odor threshold values of fresh orange juice and coldpressed peel oil emulsion of the same recoverable peel oil content; between odor threshold values of essence and coldpressed peel oil emulsions of known peel oil contents; and between odor threshold values of essence derived from fresh juice and essence from coldpressed peel oil emulsion of comparable peel oil content.

Comparisons of flavor of orange concentrates, with and without essence, to which peel oil had also been added were made. Essence was added so that it would be in the same proportion in the reconstituted juice as in the fresh juice from which it was obtained. Coldpressed peel oil was added to give a peel oil content of 0.010% v/v based on the reconstituted juice. Care was taken to adjust the reconstituted products to exactly 12° Brix and to have all the samples at the same temperature before tasting. Products were rated in flavor in order of personal preference by members of the laboratory panel. Some of the lots were tasted by representatives from industry.

RESULTS AND DISCUSSION

Quantities collected. The quantities of essence and trap condensates obtained from 10 gallons of juice are shown in Table 1. The volumes of the essence fractions were under the control of the operator. It will be noted that the trap condensates are greater in volume with the first pass. This is believed due to the deaeration that took place then which caused an increased quantity of noncondensible gases to be drawn through the traps. Other variations in the volumes recovered in the dry ice traps are primarily caused by different amounts of air leakage in different runs.

TABLE 1

Volumes of fractions obtained from 10 gallons of juice

Juice used	Vaporization	Volume of essence from column	Volume of condensate in dry ice traps
	%	*ml.*	*ml.*
Whole fruit puree:			
First pass	11.3	285	95
Second pass	14.9	318	58
Machine reamed:			
First pass	8.2	280	37
Second pass	7.4	240	31
Hand reamed:			
First pass	15.9	132	65
Second pass	14.1	178	62
Free of peel oil:			
First pass	10.5	310	90
Second pass	10.5	432	76

Recoverable peel oils. The data on oil recovery are given in Table 2. With the very high recoverable oil contents of the puree, the main oil recovery was in the decanters of the essence recovery unit, but in the other cases, the oil was found in the dry ice traps. These results indicate that in normal concentrations, peel oil would be a difficult constituent to recover under vacuum in the presence of even small quantities of water vapor.

TABLE 2

Oil recoverable from 10 gallons of orange juice

Juice type	Oil in juice	Oil recovered in essence decanters	Oil recovered in dry ice traps	Oil in stripped juice
	%	*ml.*	*ml.*	%
Whole fruit puree:				
First pass	0.88	95	7	0.56
Second pass	0.56	21	7	0.54
Machine reamed:				
First pass	0.024	0	3.5	0.006
Second pass	0.006	0	2.5	0.004
Hand reamed:				
First pass	0.006	0	3	
Second pass		0	2	
Free of peel oil:				
First pass	0.004	0	2	
Second pass		0	1	

Odor strength. In Table 3, data on the odor strength of the 2 fractions in the first and second passes from given juices are presented. In each case, the trap fraction in the first pass was the most potent. Next in potency came either the first pass essence or second pass dry ice trap condensates. Usually the second pass essence was the least potent.

TABLE 3

Relation between odor strength in fractions[a]

Juice used	First pass		Second pass	
	Essence	Traps	Essence	Traps
Whole fruit puree	0.6	1.0	0.5	0.4
Machine-reamed	0.6	1.0	0.4	0.9
Hand reamed	0.6	1.0	0.3	0.3
Free of peel oil	0.4	1.0	0.2	0.5

[a] Horizontal comparisons by groups. The sample of each group judged most potent by the panel is arbitrarily assigned a value of 1.0.

When direct comparison was made between essence derived from a juice free of peel oil of 0.004% recoverable oil and a peel oil emulsion of 0.004% oil, the threshold dilution method showed that the emulsion was 80% as strong as the essence. There is some indication of an aroma in addition to that of peel oil. Comparisons of essence from juice of 0.006% recoverable oil and peel oil emulsion of 0.006% oil showed the emulsion to be 20% stronger. A similar comparison at an oil level of 0.024% showed the emulsion to be 5 times as strong as the essence. It should be pointed out that the substantial amounts of peel oil vaporized and collected in the dry ice traps did not enter into the comparisons. Higher ratings for the oil emulsions would be expected at these levels. Using juice from the Valencia rather than the Pineapple variety and an oil level of 0.0015%, the emulsion was only 30% as strong as the essence.

In Table 4, estimations have been made of the total aromatic materials collected in the complete fraction. While the dry ice trap products were of the greatest concentrations, greater amounts were recovered in the essences from the fractionating column. These values were again arbitrarily designated as 1.0. Essence recovered in the second pass averaged around two-thirds of the amounts from the first pass. Obviously 10% vaporization is insufficient to recover all the essence.

TABLE 4

Relation between total odorous materials present in fractions [a]

Juice used	First pass		Second pass	
	Essence	Traps	Essence	Traps
Whole fruit puree	1.0	0.5	1.0	0.1
Machine-reamed	1.0	0.2	0.6	0.2
Hand-reamed	1.0	0.5	0.8	0.3
Free of peel oil	1.0	0.8	0.6	0.4

[a] Horizontal comparisons by groups. The sample of each group judged most potent by the panel is arbitrarily assigned a value of 1.0.

In Table 5, the amounts of odorous material are compared in accordance with the kind of juice used. Of the essences recovered from the column in the first pass, the largest quantity was obtained from the machine-reamed juice; somewhat less from the hand-reamed juice, and the juices free of peel oil and a comparatively small amount of odorous material from the whole fruit puree. A considerable amount of oil separated in the traps when the whole fruit puree was run, suggesting the possibility that a considerable quantity of the aromatic materials were preferentially dissolved in the oil, leaving the water layers depleted. In the second pass of this last run, less oil was present and the relative rating of the essence was higher. The results with the machine-reamed juice, the hand-reamed juice, and juice free of peel oil, show somewhat more potent water-soluble essences with higher peel oil content, but the differences were not great.

TABLE 5

Relation between odorous materials and methods of extraction [a]

Juice used	First pass		Second pass	
	Essence	Traps	Essence	Traps
Whole fruit puree	0.5	0.5	1.0	0.3
Machine-reamed	1.0	0.4	0.9	0.3
Hand-reamed	0.6	1.0	0.5	1.0
Free of peel oil	0.3	0.8	0.8	0.7

[a] Vertical comparisons by groups. The sample of each group judged most potent by the panel is arbitrarily assigned a value of 1.0.

The essence obtained from the 0.010% coldpressed peel oil emulsion was very similar in types of odor present to that obtained from fresh juice of 0.006% oil content (hand-reamed) but lacking somewhat in flowery odors. The strength was less by about ⅓. The potency of the water-soluble essence from the 0.050% peel oil emulsion appeared to be less than the 0.010% emulsion, again possibly due to the amount of peel oil separating in the first decanter, and the previously mentioned preferential solubility of odorous material in the oil layer.

A coldpressed peel oil emulsion of 0.044% oil content was 85% as strong as the orange juice of 0.044% recoverable oil content. This indicates peel oil to be the principal constituent contributing to the aroma, but possibly not all.

Effectiveness in restoring aroma. A comparison of reconstituted concentrate with added essence and without essence showed that the presence of essence did contribute to orange aroma. There was some difference of opinion in comparing desirability of products with coldpressed peel oil only and those with both essence and peel oil. Some individuals expect and look for a fairly strong peel oil taste, while others prefer milder oily taste and tend to favor the essence. The consensus of the laboratory taste panel was that essence, when freshly added, complemented the taste of coldpressed peel oil and made it approach the fresh natural flavor of oranges, but not as closely as when cut-back juice was used.

A large variation was observed in recoverable peel oil content of juices prepared by the method of Blair *(3)*. Oil content varied from 0.004 to 0.00006%. This variation is apparently due to differences in variety and maturity of the fruit.

The stability of the water-soluble essence in orange concentrate was not satisfactory. Even in storage at 0° F. (—17.8° C.) in 4-fold concentrates, the essences left no detectable aroma at the end of 6 months. A residual effect of the heightening of the peel oil flavor was noted. The aroma of peel oil did not seem to be materially affected during this storage. Additional studies are being undertaken to test this point. In no case was the development of an "apricot-like" or other off-flavor noted during storage from the use of the water-soluble essences as reported by some. It is thought possible that the "apricot-like" flavor reported by others may be due to the absence of some odorous material, most likely a peel oil fraction. The methods used by Rice *et al. (15)* and Kaufman and Campbell *(8)* would tend to give products with very little peel oil. Previously, when canned single-strength orange juices were prepared at this laboratory by the method of Blair *(3)*, juices of very low recoverable oil contents were obtained (0.001% and lower). The flavor and aroma of these juices were not well balanced and were described by some as "apricot like."

SUMMARY

A system for the recovery of water-soluble essences under vacuum at temperatures of 110-115° F. (43.3°-46.1° C.) has been developed and applied to orange juice. The orange juice is not noticeably deteriorated by processing at this temperature. With this equipment it is necessary to evaporate at least 20% of the juice in order to obtain the bulk of the essence.

A relation was found between the aroma of the essence and peel oil content. In the range of 0.004 to 0.024% recoverable oil, slightly more potent water-soluble essences were obtained with larger amounts of peel oil, but not proportionally. An orange peel oil emulsion in water also gave an essence somewhat similar to the essence from whole orange juice.

While the bulk of the water-soluble materials were collected from condensers cooled with ice water, dry ice traps were necessary to retain the peel oil when juices of 0.024% recoverable oil contents or under were used. Some water-soluble essence was also obtained in these traps.

The use of the water-soluble essence enhanced the floral character of the aroma of the freshly prepared concentrate and reconstituted product, but this aroma was lost in 6 months even with storage at 0° F. (—17.8° C.). A residual heightening of the peel oil flavor remained, but no off-flavors were formed.

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The Extraction of Pectin from Sunflower Heads

A. L. SHEWFELT

Experimental Station, Morden, Manitoba, Canada

AND

OLIVER J. WORTHINGTON

Dept. of Food Technology, Oregon State College, Corvallis, Oregon

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Strength and sag measurements of jellies prepared from sunflower head extracts are reported. A combination of oxalic acid plus ammonium oxalate for extraction was superior to the use of either one alone. Information is also given concerning the yield, grade, and general character of powdered sunflower pectin.

The two chief sources of commercial pectin have been apples and citrus fruits. The apple juice industry has provided large quantities of pomace which can be dried and used as raw material for pectin manufacture. Likewise, the recent strides in the manufacture and merchandising of citrus juices has given rise to huge amounts of rinds suitable for pectin recovery. Despite these established sources, the versatility of pectic substances and their potential industrial applications have continuously prompted investigators to study new sources and properties. A detailed review of these studies has been presented by Kertesz *(4)*. One of the newer sources included in this review is sunflower heads.

Colin and Lemoyne *(3)* first suggested the presence of pectin in the pith of sunflower plants. Stoikoff *(8)* later extracted pectin from heads with a solution of 0.5% oxalic acid. He recovered the pectin and stated that it had jellying quality comparable to that of apple pectin. He reported a yield of 23.6% based on the air-dry weight of the heads. The pectin was 45.7% esterified and had a galacturonide content of 87.3%.

Investigations of pectin in sunflower heads have been limited largely because of the few areas in which sunflowers are grown commercially. One of these areas showing great promise is in southern Manitoba, which has produced commercial crops since 1946. In 1949, 60,000 acres were grown and harvested *(7)*. At the present time, edible oil is recovered from the seed and the residue is used as a feed supplement. The seed hulls are pressed into logs for fuel. The seed heads or receptacles obtained in the harvesting operation are worked back into the soil.

The possibility of obtaining an important source of pectin from the material now being worked back into the soil, offers a stimulus toward study in developing a commercial method of pectin extraction. Results of several extraction procedures and their relation to gel characteristics are reported in this paper. A later paper will discuss a study of methods employed in the recovery of dry powdered pectin and comparisons with commercial products from other sources.

EXPERIMENTAL PROCEDURE

The threshed heads were dried in warm air until brittle and then ground in a plate-type grinder to pass an 8-mesh screen.

TABLE 1

Calcium pectate and extraction pH values with different types and concentrations of extractant

Extractant concentration %	Oxalic acid		Hydrochloric acid		Sodium tetraphosphate		Sodium hexametaphosphate	
	Calcium pectate %	(Extractant pH)	Calcium pectate %	(Extractant pH)	Calcium pectate %	(Extractant pH)	Calcium pectate %	(Extractant pH)
0.25	16.4	(4.01)	4.1	(2.96)	11.1	(5.73)	9.6	(5.49)
0.50	18.2	(3.32)	9.9	(1.83)	15.2	(5.74)	9.2	(5.49)
0.75	17.5	(2.98)	11.7	(1.48)	16.3	(5.80)	9.5	(5.50)
1.00	16.6	(2.38)	12.3	(1.20)	19.5	(5.93)	10.7	(5.52)
2.00	13.9	(1.72)	12.8	(0.94)	24.1	(6.26)	18.1	(5.56)

The meal had a moisture content of approximately 11.0%. The pectin content of the meal as calcium pectate was first studied. Extractants included solutions of oxalic acid, hydrochloric acid, sodium tetraphosphate, and sodium hexametaphosphate. Five grams of the meal were refluxed with 100 ml. of the extracting solution for 20 minutes at boiling temperature. The extract mixture was then cooled, made up to 150 g. with water, and centrifuged. A 10 ml. aliquot of the filtered supernatant extract was precipitated with 40 ml. of 95% ethyl alcohol. The precipitate was dissolved in hot water and made up to 400 ml. with water. The Carre and Haynes method *(2)* was then applied and the results reported as calcium pectate. The concentration of extractant in the extracting solution varied from 0.25 to 2.00%.

A modification of the Mottern and Karr procedure *(6)* for determining the pectin grade of apple pomace was used to study the jellying capacity of sunflower head extracts. The crude extracts for jelly tests were prepared as follows:

Samples of sunflower meal varying from 8 to 15 g. were weighed accurately and transferred to a 500 ml. wide-mouth Erlenmeyer flask together with a weighed quantity of oxalic acid crystals (0.5 to 3.0 of the dihydrate form). Two hundred grams of boiling, distilled water was added with mixing and the flask loosely stoppered and set in a water bath at 90° C. for 60 minutes. The flask contents were then centrifuged and the supernatant strained through 2 layers of fine cheesecloth. The extraction pH values for the above treatments varied from 1.9 to 4.2. It was found impractical to extract samples of more than 15 g. with the 200 g. of liquid since the extract mixture developed such a high viscosity that insufficient extract could be separated.

The value of hydrochloric acid and also citric acid for extraction was investigated. Increments of sodium tetraphosphate and sodium hexametaphosphate were added to the extraction mixture to note the possible effect on the jellying quality of the crude extracts. A number of extractions with sodium tetraphosphate alone were included. Extraction with potassium oxalate and ammonium oxalate and in combination with oxalic acid were also conducted. Lastly, a combination of hydrochloric acid and ammonium oxalate was employed.

In addition to the effects of specific extractants, the effects of pH, time, and temperature of extraction were studied as well as the effect of a preliminary extraction at 40° C.

Test jellies were prepared with portions of the crude extract and were subjected to breaking strength and sag measurements.

For breaking strength measurements, a 60-g. aliquot of the crude liquid extract was brought to a boil and 100-g. of sucrose (less the soluble solids of the extract) was added. The mixture was concentrated by boiling to 65% soluble solids, and poured into a No. 63 Hazel-Atlas jelly glass. It was skimmed, air cooled, sealed and stored in an air oven at 25° C. for 18 hours. The breaking strength of the jelly was then determined by means of a Delaware jelly strength tester[a] and the pH, soluble solids, and general character of the jelly noted.

For sag measurements, a 108-g. aliquot of crude extract was used and the soluble solids brought up to 180 g. with sugar. The mixture was concentrated to 280 g. before pouring. The standard Exchange Ridgelimeter[b] and jelly glasses were employed.

The pH of the test jellies was varied by adding increments of oxalic acid to the sugar used in jelly preparation. For comparative purposes, hydrochloric, sulfuric, tartaric and citric acids were also used for pH adjustment.

RESULTS AND DISCUSSION

The calcium pectate value of the sunflower meal varied widely with both type and concentration of extractant. Extractions with oxalic acid were dark in comparison with the more acid treatments. The comparatively low viscosities of the polyphosphate extractions even when adjusted to a lower pH following extraction suggested that the extract was of low jellying quality. Extractions with oxalic acid were much more viscous than those with hydrochloric acid and thus showed most promise for pectin recovery.

A study of the effects of extraction time and temperature with 0.5% oxalic acid upon the calcium pectate value showed that maximum calcium pectate was obtained with an extraction temperature of 100° C. and an extraction time of 10 to 20 minutes. Further studies of the calcium pectate content of the meal were discontinued since they gave no information concerning the quality of the pectin for jelly purposes.

A series of extractions with different concentrations of hydrochloric acid solutions and in which the pH varied from 5.60 to 2.75 failed to produce extracts having jellies of measurable strength. Extractions with varying concentrations of citric acid followed by pH adjustment of the test jellies with oxalic acid, likewise failed to give any jellying. A sample of sunflower pectin isolated from the meal showed 50.0% esterification and 79.8% galacturonide. The relatively low esterification value explained in part, the extraction deficiencies of such acids.

With 10-, 12-, and 15-g. samples of meal and varying quantities of oxalic acid for extraction, the maximum jelly strength was given when the extraction pH was 2.8 to 3.0 (Table 2).

This led to a study of sample size and its relation to the strength of jellies prepared from the resulting extracts. Extraction of samples (at 1-g. intervals) from 8 to 15 g. with 1.50 and 2.00 g. of oxalic acid also gave maximum jelly strength when the extraction pH was 2.8 to 3.0. The jelly pH in these studies was not adjusted and resembled closely the values for extraction pH. It was thus not clearly understood whether the optimum pH values reflected favorable extraction conditions or favorable jelly acidities.

To this end, a series of 12-g. samples was extracted with 1.00, 1.25 and 1.50 g. of oxalic acid and a series of 10-g. samples with 0.75, 1.00, 1.25 and 1.50 g. of oxalic acid. Both series were adjusted with oxalic acid to give

[a] Obtained from Arthur H. Thomas Co., Philadelphia, Pa.

[b] Obtained from California Fruit Growers Exchange, Ontario, Calif.

TABLE 2

Strength of jellies and extract pH values for extracts from 10, 12, and 15 grams of meal

Oxalic acid in extract g.	Sample weight					
	10 g.		12 g.		15 g.	
	Jelly strength g./cm.²	(Extract pH)	Jelly strength g./cm.²	(Extract pH)	Jelly strength g./cm.²	(Extract pH)
0.50	0.0	(3.90)	0.0	(4.08)	0.0	(4.13)
0.75	0.0	(3.59)	0.0	(3.80)	11.7	(3.83)
1.00	12.3	(3.27)	17.5	(3.44)	22.6	(3.62)
1.25	18.0	(3.04)	20.6	(3.27)	29.5	(3.33)
1.50	23.0	(2.81)	32.5	(3.01)	35.0	(3.25)
1.75	17.5	(2.51)	27.4	(2.80)	42.0	(2.97)
2.00	16.3	(2.29)	29.7	(2.56)		
2.25	13.6	(2.15)	29.4	(2.39)		
2.50			26.0	(2.21)		
2.75			21.2	(2.11)		
3.00			19.0	(1.98)		

a range of jelly pH. With this pH adjustment the maximum breaking strength for extraction between pH 2.95 and 3.58 was now obtained at a jelly pH between 1.5 and 2.0 (Table 3). Apparently, the extraction at pH 2.70 was sufficiently acidic to have a degrading effect on the pectin.

Adjustment of the jelly pH with sulfuric acid rather than oxalic resulted in a similar pattern of jelly strength values and suggested that the type of acid for pH adjustment was not as critical as for extraction. A more detailed study of the comparative effects of oxalic, hydrochloric, citric and tartaric acids for jelly pH adjustment showed, however, that the jelly strength pattern was influenced in part by the type of acid (Table 4). The maximum jelly strengths for oxalic, hydrochloric, and tartaric acids were obtained at pH values of approximately 1.62, 1.35 and 2.00 respectively. No maximum was obtained with citric acid. There was a noticeable minimum jelly strength at the lower increments of hydrochloric, citric, and tartaric acids which was not apparent with oxalic acid.

Addition of increments of sodium tetraphosphate and also sodium hexametaphosphate to the oxalic acid used for extraction, in amounts up to 6% of the weight of the meal, gave no significant increase or decrease in the jelly strength of the extract.

A series of 11-g. samples extracted with 1.00 g. sodium tetraphosphate and 200 ml. water at pH 5.54 showed some jellying when the jelly pH was adjusted to between 1.49 and 2.58. A maximum jelly strength of 11.4 g./cm.² was given at pH 2.01.

Extraction of 11-g. samples of meal with 2 levels of ammonium oxalate and potassium oxalate showed a marked shift in the optimum pH of jellying compared with the oxalic acid extractions. (Table 5). Maximum jelly strength occurred at pH 2.8 to 3.0 instead of 1.8 to 2.0.

No measurable jelly strength occurred above pH 3.56. The jelly strength values obtained with ammonium oxalate were somewhat higher than those with potassium oxalate. The extraction pH values with the 2 levels of ammonium oxalate were 5.65 and 5.68, respectively, and with the potassium oxalate 5.70 and 5.72. A further and more complete study of ammonium oxalate extractions showed that maximum jelly strength occurred at a pH of approximately 2.80. Jelly strength decreased rapidly above pH 3.34 and below pH 2.50. Although the extraction pH was even slightly higher with the oxalate salts than with sodium tetraphosphate, the jelly quality of the extracts was substantially higher.

Extraction of 11-g. samples of meal with 0.5 g. of oxalic acid plus either 0.5 g. of ammonium oxalate or 0.5 g. of potassium oxalate resulted in higher jelly strength values than those from extractions with either oxalic acid or oxalate salts alone.

In a study of extractions with various proportions of oxalic acid and ammonium oxalate the treatments listed in Table 6 were included. With the exception of

TABLE 3

Effects of extraction pH and jelly pH on the jelly strength of extracts from 10- and 12-gram samples

Oxalic acid added in jelly g./100 g. sugar	10 gram sample—pH of extraction								12 gram sample—pH of extraction					
	3.58		3.20		2.95		2.70		3.48		3.20		2.97	
	J. S. g./cm.²	Jelly pH	J. S. g./cm.²	Jelly pH	J. S. g./cm.²	Jelly pH	J. S. g./cm.²	Jelly pH	J. S. g./cm.²	Jelly pH	J. S. g./cm.²	Jelly pH	J. S. g./cm.²	Jelly pH
0.0	11.0	(3.71)	13.8	(3.31)	22.2	(3.06)	22.3	(2.70)	13.0	(3.58)	23.5	(3.35)	28.5	(3.00)
0.1	15.5	(3.23)	19.8	(2.84)	25.5	(2.58)	21.2	(2.29)	25.0	(3.18)	31.5	(2.94)	31.5	(2.64)
0.3	24.5	(2.33)	28.0	(2.04)	28.5	(1.91)	20.0	(1.77)	33.8	(2.35)	34.5	(2.22)	39.5	(1.98)
0.5	26.3	(1.80)	28.5	(1.71)	27.8	(1.68)	21.3	(1.52)	37.5	(1.84)	37.0	(1.82)	39.2	(1.68)
0.7	26.0	(1.58)	27.9	(1.53)	26.3	(1.51)	22.7	(1.39)	34.2	(1.61)	34.5	(1.69)	33.8	(1.54)
0.9	23.0	(1.45)	26.3	(1.41)	23.8	(1.40)	20.2	(1.31)	30.7	(1.44)	32.0	(1.53)	32.5	(1.44)
1.1	21.0	(1.35)	23.0	(1.32)	20.5	(1.32)	20.5	(1.25)	29.0	(1.37)	24.5	(1.40)	29.5	(1.36)

TABLE 4

The effect of type of acid for pH adjustment upon jelly strength

Oxalic acid			Hydrochloric acid			Citric acid			Tartaric acid		
Amt. added g./100 g. sugar	Jelly strength g./cm.²	Jelly pH	Amt. added ml./100 g. sugar	Jelly strength g./cm.²	Jelly pH	Amt. added g./100 g. sugar	Jelly strength g./cm.²	Jelly pH	Amt. added g./100 g. sugar	Jelly strength g./cm.²	Jelly pH
0.00	23.0	(3.14)	0.00	23.0	(3.12)	0.00	22.7	(3.13)	0.00	23.0	(3.13)
0.05	24.5	(2.94)	0.05	21.0	(2.82)	0.15	21.5	(2.99)	0.15	21.0	(2.85)
0.10	24.7	(2.74)	0.10	19.2	(2.58)	0.60	20.9	(2.68)	0.30	19.2	(2.67)
0.20	24.7	(2.40)	0.15	21.5	(2.28)	1.50	22.5	(2.34)	0.60	22.1	(2.45)
0.30	27.5	(2.01)	0.20	23.5	(1.93)	2.10	23.5	(2.28)	0.90	23.7	(2.27)
0.50	28.0	(1.62)	0.30	29.2	(1.45)	2.70	23.7	(2.13)	1.50	25.8	(2.09)
0.70	27.8	(1.43)	0.40	30.7	(1.35)				2.10	29.4	(2.00)
0.90	27.2	(1.32)	0.50	23.7	(1.06)				2.70	26.1	(1.82)

TABLE 5

Strength and pH of jellies from ammonium oxalate and potassium oxalate extractions

Oxalic acid added in jelly g./100 g. sugar	Ammonium oxalate for extraction g.				Potassium oxalate for extraction g.			
	1.00		1.50		1.00		1.50	
	Jelly strength g./cm.²	Jelly pH	Jelly strength g./cm.²	Jelly pH	Jelly strength g./cm.²	Jelly pH	Jelly strength g./cm.²	Jelly pH
0.3	0.0	3.64	0.0	3.75	0.0	3.56	0.0	3.68
0.6	29.2	2.80	28.0	3.00	20.5	2.66	21.7	2.86
0.9	14.0	1.98	19.6	2.30	14.5	1.94	12.5	2.06
1.2	14.7	1.63	13.4	1.82	13.2	1.60	10.7	1.70

TABLE 6

Increments of combined oxalic acid and ammonium oxalate in extraction treatments

Treatment no.	Oxalic acid g.	Ammonium oxalate g.
1	1.00	0.00
2	0.75	0.25
3	0.50	0.50
4	0.25	0.75
5	0.00	1.00

Treatment 1, all extractions showed a maximum jelly strength value when adjusted with oxalic acid to pH 2.5 to 3.0 (Figure 1). The extraction pH values for the 5 treatments were respectively 3.30, 3.68, 4.08, 4.40 and 5.60. Highest jelly strengths occurred when the proportions of oxalic acid and ammonium oxalate were equal. The results also indicated that the most favorable extraction pH was approximately 4.0. Extraction in which this pH was obtained with a combination of hydrochloric acid and ammonium oxalate gave lower jelly strengths than those with oxalic acid and ammonium oxalate.

Assuming the strength of a standard jelly to be 33.5 g./cm.² according to Baker and Woodmansee *(1)*, the grade value of meal was calculated in a similar manner to that used by Mottern and Karr for apple pomace *(5)*. Meal extracted with equal proportions of oxalic acid and ammonium oxalate had a grade value of 39.

Although the calcium pectate yields indicated that the most complete extraction of pectin occurred at a temperature of 100° C. for 10 to 20 minutes, preliminary trials showed that more favorable jellying took place by extracting at a lower temperature and for a longer period of time. Jellies prepared from oxalic acid extracts at pH 3.36 and adjusted with oxalic acid to pH 1.7 to 1.8 indicated an optimum temperature of 80° C. (Table 7). Extractions at 98.5° C. showed a consistent decrease in jelly strength with increasing time of extraction. Extractions with oxalic acid plus ammonium oxalate, at pH 4.03 and adjusted to pH 2.7 to 2.8 in the jellies did not show as marked time and temperature effects as the extractions with oxalic acid alone. In general, but not invariably, favorable extraction conditions were provided at a temperature of 90° C. for 60 minutes.

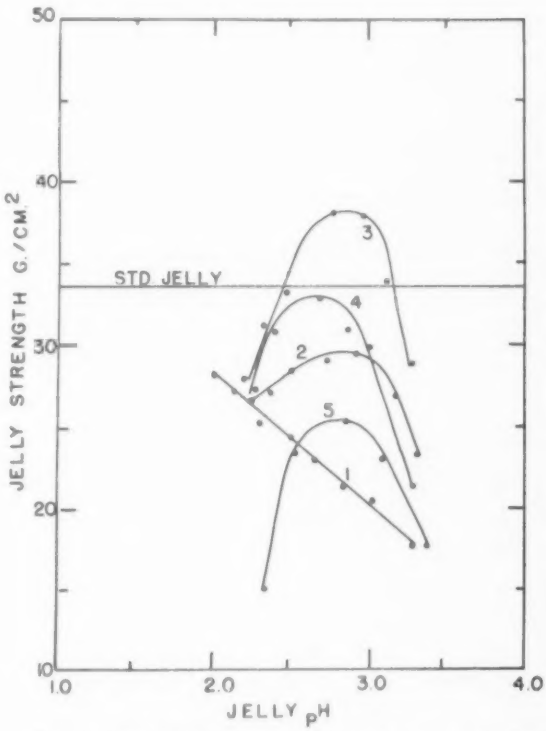

Figure 1. Effect of proportions of oxalic acid and ammonium oxalate upon jelly strength of crude extracts. (Numbers refer to treatments, Table 6.)

A preliminary extraction at 40° C. prior to the normal extraction at 90° C. reduced the jelly strength by 60 to 70% and indicated strongly the presence of pectic enzymes in the meal.

A study of the sag values of jellies prepared from oxalic acid extracts indicated that the sag was greater than expected for a given jelly strength (Table 8). Some jellies which approached a standard strength of 33.5 g./cm.² were at the upper limit of measurement with the Ridgelimeter since the sag values were 28% or higher. Also the optimum pH for minimum sag was lower than for maximum jelly strength. Neither the sag nor the jelly strength values were affected substantially by the variations in extraction treatment. Assuming the percentage sag of a standard sunflower pectin jelly was 23.5%, the corresponding jelly strength according to these data was approximately 40 g./cm.².

TABLE 7

Effect of time and temperature of extraction upon jelly strength of extract

Extraction temperature ° C.	Jelly strength g./cm.² Oxalic acid extraction				Jelly strength g./cm.² Oxalic acid plus ammonium oxalate extraction			
	20 min.	30 min.	40 min.	50 min.	40 min.	60 min.	80 min.	100 min.
70	29.4	27.8	29.0	28.5	25.7	30.6	34.1	35.2
80	31.0	33.7	31.4	34.5	31.3	33.7	35.6	37.1
90	29.2	30.5	28.7	24.3	33.7	34.3	34.8	35.6
98.5	25.4	22.5	18.8	15.0	34.3	35.7	36.6	33.2

TABLE 8

Jelly strength, sag, and pH values of test jellies from extracts of 11, 13, and 15 g. samples

Oxalic acid for extraction g.	Oxalic acid added in jelly* g./180 g. sugar	Jelly strength g./cm.²			Sag %			Extract pH			Jelly pH		
		11 g.	13 g.	15 g.	11 g.	13 g.	15 g.	11 g.	13 g.	15 g.	11 g.	13 g.	15 g.
1.00	1.25	32.5	38.0	45+	28.6	24.6	20.8	3.32	3.46	3.58	1.62	1.69	1.81
	1.50	26.0	37.0	45.0	28.6	24.4	20.4				1.50	1.58	1.65
	1.75	26.3	40.4	45.0	28.6	23.2	20.1				1.38	1.46	1.53
1.25	1.25	29.5	37.4	45+	28.2	24.2	20.3	3.07	3.24	3.38	1.50	1.60	1.70
	1.50	24.7	38.7	45+	28.0	25.0	20.8				1.40	1.48	1.58
	1.75	24.7	35.2	45+	28.2	24.6	20.1				1.30	1.40	1.48
1.50	1.25	28.0	38.5	45+	29+	24.0	21.0	2.82	3.01	3.22	1.52	1.54	1.70
	1.50	26.2	38.0	44.2	29+	24.5	21.8				1.44	1.48	1.58
	1.75	24.5	39.0	41.7	29+	23.7	21.0				1.37	1.39	1.46

* The oxalic acid increments listed here are for the jellies in the sag tests only. The corresponding values for the jelly strength test jellies were 0.69, 0.83 and 0.97 g./100 g. sugar.

Investigations, not reported in detail in this paper, indicated that the yield of dry powdered pectin amounted to 14 to 18% of the dry basis head weight. The grade of this pectin was approximately 150. The relative viscosity of 0.5% sunflower pectin solutions between pH 2.0 and 3.0, were abnormally high in comparison with apple and citrus pectins. At pH 1.98, the sunflower pectin solution had a relative viscosity of 7.0. A peak value of 114.0 was obtained at pH 2.48 and dropped to 8.8 at pH 3.04. The exceptionally high peak was attributed to the occurrence of gelation between pH 2.0 and 3.0.

Both the yield and quality of sunflower pectin were affected by the season, maturity and condition of the heads. The effects of these variables will also be reported in a later paper.

SUMMARY

The pectin content of the sunflower heads determined as calcium pectate varied markedly *(5)* with type and concentration of extractant and also with time and temperature of extraction.

Jellies prepared from oxalic acid extracts had maximum jelly strength when the pH of the jelly was adjusted to 1.5 to 2.0. Extractions at pH 2.70 or lower resulted in reduced jelly strength and indicated pectin degradation with excess acid.

The addition of sodium tetraphosphate or sodium hexametaphosphate with the oxalic acid for extraction gave no significant increase in the jelly strength. Extractions with sodium tetraphosphate alone at pH 5.54 gave weak jellies between pH 1.49 and 2.58.

Ammonium oxalate extracts showed higher jelly strength than those of potassium oxalate. Jellies from both had maximum strength at a pH of approximately 2.8.

The most favorable extraction treatment was provided by a combination of equal proportions of oxalic acid and ammonium oxalate. For this mixture, the optimum extraction pH was approximately 4.0. Extraction at 90° C. for 60 minutes was generally most favorable. The calculated grade value of the sunflower meal under these extraction conditions was approximately 39. Preliminary extraction of the sunflower meal for one hour at 40° C. substantially reduced the jelly strength of the resulting extract.

The yield of recovered pectin normally varied from 14 to 18% of the dry-basis head weight and had a grade value of approximately 150. Both yield and quality of sunflower pectin were affected by the climatic season, maturity, and condition of the heads.

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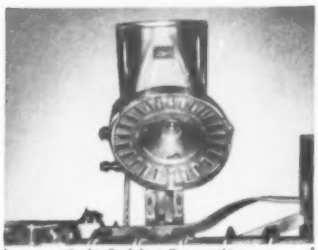
MORTON
for all your canning salt needs

Whatever your salt requirements are in your canning operation, Morton can fill them promptly and economically . . . from a complete line of high grade canning salts available from 9 strategically located plants.

These specialized canning salts include *Morton 999*, a high purity salt; *Morton H. G. Granulated*, a screened, high grade, evaporated salt of improved purity, controlled quality and uniformity; *Morton K. D. Granulated*, a superior quality of evaporated salt; and *Morton Rock Salt*. A Morton Consulting Engineer will be glad to recommend the salt best suited for your needs.

The RIGHT salting method for your plant



Salt Tablet Depositor

Deposits *one* tablet in *each* can at high speeds with never-fail accuracy. The tablet depositor enables the canner to get the *exact* amount of salt, or other made-to-order mixtures, into each and every can.

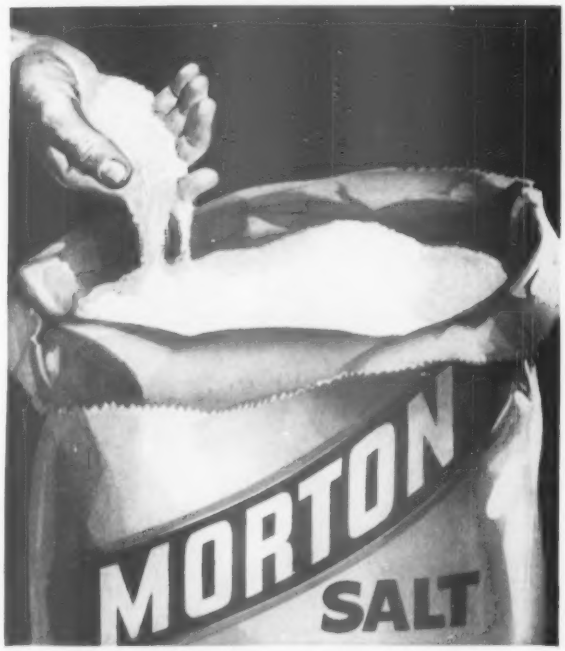
Bulk Salter

For precision salting of canned foods by the economical bulk method. Designed for either plant-blended mixtures or quick-dissolving Morton Salt. Buying salt in bags and dispensing accurately metered amounts into each can with the Bulk Salter saves real money.

Brinemaker

Delivers up to 800 gals. of clear, fully saturated brine per hour, using the type of salt that is most economical or best suited for each plant. Saves labor — brine can be pumped under pressure from ground floor to upper levels.

The RIGHT salt for your operation



MORTON SALT COMPANY
Industrial Division
Dept. CS-4, 120 S. LaSalle St.
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I would like more information on:

- ☐ Morton Canning Salt
- ☐ The Brinemaker
- ☐ The Bulk Salter
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Huron field men and technical service organization are qualified to help you

add more selling flavor

to your food products...

If there is any question in your mind as to what Huron MSG or HVP can do in improving the flavor of your food product, simply drop a line to our Technical Service Department. We will be glad to supply free working samples and advice as to use —so you can see for yourself!

Huron **MSG-HVP**

monosodium glutamate — hydrolyzed vegetable protein

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General Sales Office: 9 Park Place, New York City 7 • Factories: Harbor Beach, Mich.
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Abstracts

(Continued from page 22)

that cornstarch, by reducing the rate of passage of the ration through the gastrointestinal tract, promotes more efficient utilization of low casein rations.

Effect of deficiency of magnesium and other minerals on protein synthesis.

MENAKER, W., AND KLEINER, I. S. *Proc. Soc. Exptl. Biol. Med., 81,* 377-8 (1952).

Controls receiving a complete mineral supplement gained over one-third more wt. than rats on a Mg deficient diet. The unfavorable effect of Mg deficiency on the synthesis of protein appears to be approx. as great as that reported for K deficiency, although there is far more K than Mg in muscle and viscera.

Dietary proteins: their function in health and disease.

ALLISON, J. B. *J. Agr. Food Chem., 1,* 71-4 (1953).

An imbalance in protein stores results from insufficient or poor quality dietary protein, reduced caloric intake or malnourishment from disease. This imbalance is characterized by a shift in the distribution of blood and tissue proteins; some are greatly reduced, others are even increased. The pattern of enzyme systems is altered markedly in the liver, less so in some other tissues. A shift in metabolism, involving all nutrients, is assocd. with loss of tissue proteins. Malnourishment can lead to an increase in anabolic processes, so that nitrogen retention and tissue regeneration are more efficient in the depleted than in the normal animal. The protein stores can be regenerated or maintained by feeding the proper mixt. of amino acids either orally or intravenously. Regeneration to a normal balance is most rapid in the presence of a pattern of amino acids such as is represented by whole egg proteins. Nitrogen balance is an integration of gains and losses from different tissues and is a function of many variables such as the dietary protein, protein stores, and endocrine balance.

Effect of protein source on maintaining blood and sugar levels after breakfast.

COLEMAN, M. C., TUTTLE, W. W., AND DAUM, K. *J. Am. Dietet. Assoc., 29,* 239-44 (1953).

Data were collected from 13 normal subjects, 8 males and 5 females between the ages of 16 and 27 years, relative to the effect of the protein source in breakfast on the course of the blood sugar level following breakfast. In addn., data presented by other investigators were used for comparison. As far as the breakfasts considered are concerned, the data presented justify the following conclusions: (a) Breakfasts in which the protein was 95% of animal origin were equally as effective in maintaining the blood sugar above the fasting level as breakfasts in which the protein was almost exclusively of plant origin. (b) The consumption of breakfast in which the protein is a combination derived from animal and plant sources is as effective in elevating and maintaining the blood sugar above the fasting level as the consumption of a breakfast in which the protein is almost wholly of either plant or animal origin.

Effects of increased protein intake in older people.

KOUNTZ, W. B., ACKERMAN, P. G., KHEIM, T., AND TORO, G. *Geriatrics, 8,* 63-9 (1953).

Studies indicate that difficulties may be encountered in maintaining elderly persons on high protein diets for long periods when the daily intake is more than 1.5 g. of protein per kg. of body wt., or 100 g. This especially applies if the protein is supplied by a diet rich in meat, eggs and milk without feeding of supplementary protein. An increase in nonprotein nitrogen was demonstrated with increase in protein in the diet which suggests that care should be exercised in limiting the amt. of protein fed to the older individual.

Effects of prolonged ingestion of xylose on rats.

BOOTH, A. N., WILSON, R. H., AND DE EDS, F. *J. Nutrition, 49,* 347-55 (1953).

Xylose was fed for periods up to 140 days to rats at various levels from zero to 25% of the diet. Thirty-five per cent xylose

was fed for short periods. In weanling rats, a level of 15% or more was found to produce lens opacities, which regressed to a considerable degree with time whether or not the animals were continued on the exptl. diet. The regression was never complete. Other toxic symptoms observed were diarrhea, bloating, and liver changes suggestive of storage. A voluntary restriction of utilizable food by the xylose-fed rats led to decreased rates of growth. Rats rendered diabetic with alloxan experienced more severe lens opacities when fed xylose than did diabetic controls. Pending more favorable exptl. data at lower levels of intake, it is deemed inadvisable to risk the incorporation of xylose in foods at any level of intake for extended periods of time.

Effect of factors other than choline on liver fat deposition.

LITWACK, G., HANKES, L. V., AND ELVEHJEM, C. A. *Proc. Soc. Exptl. Biol. Med., 81,* 441-5 (1952).

A no. of factors under the exptl. conditions used influence fat deposition in the liver: the availability of niacin to the animal, the type of carbohydrate used in the ration and type and level of protein used. Individual amino acids and mixts. of amino acids which support optimal growth conditions do not produce min. levels of fat in the liver.

The relative cariogenicity of sucrose when ingested in the solid form and in solution by the albino rat.

HALDI, J., WYNN, W., SHAW, J. H., AND SOGNNAES, R. F. *J. Nutrition, 49,* 295-306 (1953).

Albino rats of the Wistar strain developed no carious lesions when they were fed entirely by stomach tube a high sucrose diet which had previously been shown to be cariogenic when ingested orally. When all the components of this food mixt. except sugar were fed by stomach tube and granulated sugar was ingested orally, the animals having been desalivated for the greater part of the expt., there developed an appreciable no. of carious areas and an appreciable caries score. When, under the same exptl. conditions, sugar was ingested in a 40% aq. soln., the no. of carious areas and the caries score were markedly less than when the same amt. of sugar was eaten in the solid form. Sugar in soln. was therefore found in these expts. to be much less cariogenic than granulated sugar.

Calcium and phosphorus intake in senile osteoporosis.

VINTHER-PAULSEN, N. *Geriatrics, 8,* 76-9 (1953).

The calcium intake of 33 old patients showed marked individual variations (ranging from 200 to 1100 mg.) despite the fact that none of the subjects was suffering from loss of appetite due to acute disease and that milk and cheese were available *ad libitum.* A study of the incidence of seni[illegible] osteoporosis, as evidenced by x-rays of the vertebral column, showed a marked correlation between a low calcium and phosphorus intake and a high incidence of osteoporosis. The theories advanced regarding the etiology and pathogenesis of senile osteoporosis are discussed. The present study appears to stress the significance of nutrition in this disorder.

Energy requirements of dogs.

UDALL, R. H., RANKIN, A. D., AND MOSS, L. C. *Veterinary Medicine, 48,* 111-14 (1953).

A report on the factors to be considered in estg. the energy requirement of dogs and a rapid method of calcn. based on the studies of the metabolic rate of dogs under kennel conditions. A study of energy requirements is useful for detg. the nutritional needs of the animals.

PHYSIOLOGY

Experiments in aging.

LANSING, A. I. *Sci. Am., 188,* 38-42, April 1, 1953.

The rotifer was used to study what dets. the life span of organisms. The author suggests that growth cessation itself may set off the aging process. Possibly the growth factor, growth regulator and aging factor are one and the same material, producing different physiol. effects in different concns. Indications were that the older the mother, the shorter were the lives of the off-spring. Studies with human beings also have

FLAVOR NEWS

AN AMAZINGLY EFFECTIVE REPLACEMENT FOR COUMARIN TO MEET THE NEEDS OF THE TIMES

From the research laboratories of Florasynth Laboratories, Inc. comes a new ingredient... PROTOVANOL "C" . . . a more than satisfactory replacement for the discontinued Coumarin. With the restriction by the Federal Food and Drug Department, the requirement for a practical yet economical replacement has indeed been a source of considerable concern to many extract firms and manufacturers. To this extent Florasynth has created PROTOVANOL "C", which in the opinion of the trade, has already proved by practical test and comparison—the flexibility and utility vital to the quality and success of food products . . .

For your test purposes we are making available PROTOVANOL "C" at the volume price of $5 a lb.

PROTOVANOL C

Ounce for ounce, PROTOVANOL "C" is the approximate equivalent of Coumarin in strength . . . is fully soluble in alcohol, propylene, and to an extent even in vegetable oils . . .

It has amazing versatility . . . readily mixed in various dry bases . . . and readily absorbed in cane sugar, corn sugar or starch . . .

Florasynth LABORATORIES, INC.
CHICAGO 6 • NEW YORK 61 • LOS ANGELES 21

Abstracts

indicated that maternal age influences the longevity of the offspring.

FOOD AND FOOD TECHNOLOGY

How bakery products react to low temperature freezing.

GLABAU, C. A. *Bakers Weekly, 158,* 56', April 13, 1953.

The freezing of bread doughs has no apparent effect upon the life and activity of the yeast. The bread produced with 2½% yeast proofed well and also baked normally. There is no value in retarding the doughs in the conventional refrigerator before they are subjected to the freezing temp. Doughs frozen directly after they are placed into the pan produce bread that is more tender and slightly softer than when doughs are given half proof before freezing.

New strawberry wash routine cuts mold count; machine designed.

Glass Packer, 32, 42, March, 1953.

The new equipment gently forces the fruit up and down in the detergent soln. while it is made to travel the length of the washer. Principal advantages over the conventional soaker-washers come from better cleaning by forcing the berries through the soln. instead of permitting them to ride with the current. Having berries individually conveyed through the water also eliminates pushing action between berries. The cost of adding the detergent to the soln. is quite low, particularly when the losses due to the condemned berries and the price differential between the various grades of berries is considered. On the basis of using 10 gal./min. of 0.1% soln. of detergent, the cost was less than seven-hundredths of a cent/pound of berries processed.

Chemical in poultry food to fight disease.

Science News Letter, 63, 68 (1953).

With the hope of helping to prevent air sac disease of poultry, which may kill up to 50% of affected chickens and turkeys, the Food and Drug Administration issued a new regulation permitting addn. of para-aminobenzoic acid to poultry feed. It may be added directly to feeds or with the antibiotic formula used to promote growth.

ORGANIC CHEMISTRY

Degradation of sugars on ion-exchange columns of Amberlite IRA 400 (OH).

PHILLIPS, J. D., AND POLLARD, A. *Nature, 171,* 41-2 (1953).

Fructose, sucrose and glucose were retained on IRA 400 columns but not on IR 120 columns. There was considerable degradation of glucose and fructose with the production of org. acids. Sucrose was not degraded on the column, and could be removed from the column by elution with *N* ammonium carbonate.

Urea complexes of rape-oil fatty acids.

KELLON, J. H. S., AND TAYLOR, C. G. *Nature, 171,* 266 (1953).

A fractionation of mixed rape-oil fatty acids utilizing the formation of urea complexes is described.

ANNUAL MEETING BULLETIN BOARD

It's Los Angeles in '54
June 27 through July 1

Organization for the 1954 National Meeting

President of the Institute—Berton S. Clark (American Can Co., Maywood, Ill.).

President-elect—Philip K. Bates (Carnation Co., Los Angeles).

Executive Secretary—Charles S. Lawrence (Institute of Food Technologists, 176 West Adams, Chicago).

Chairman National Program Committee

Arthur N. Prater (Gentry Division, Consolidated Grocers Corp., Box 2076 Terminal Annex, Los Angeles 54).

General Chairman

Milton E. Powell (Knudsen Creamery Co., 1974 Santee Street, Los Angeles).

Chairman Southern California Section

Max S. Dunn (Univ. of California at Los Angeles).

Chairmen of Local Committees

Exhibits—John S. Beckett (Asceptic-Thermo Indicator Co.).

Hotel—Marsdon S. Burns (Vegetable Concentrates Inc.).

Banquets—Willard E. Baier (Sunkist Growers).

Registration—Louis B. Rockland (Fruit and Vegetable Chemistry Lab.).

Finance—Robert N. Brainerd.

Hospitality—Gordon L. Merchant (Merck and Co.).

Arrangements—Raymond E. Cox (Bireley's Div., General Foods Corp.).

Entertainment—Theodore B. Ayres (American Can Co.).

Ladies' Entertainment—Marjorie Heid (Food Consultant, Fullerton, Cal.).

Publicity—J. Raymond Lindquist (Rexall Drug Co.).

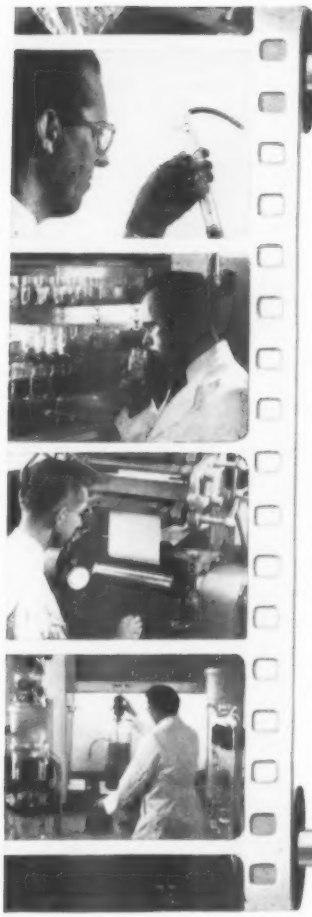
Printing—John W. Koehler (Pfaudler Sales Co.).

FUTURE DATES FOR FOOD TECHNOLOGISTS

1953	
August 10-14	Conference on Food and Nutrition, Gordon Research Conference (American Association for the Advancement of Science) Colby Junior College, New London, New Hampshire.
September 6-9	American Institute of Biological Sciences, University of Wisconsin, Madison
September 6-11	One hundred and twenty-fourth Meeting of the American Chemical Society, Chicago, Illinois
September 13-16	American Institute of Chemical Engineers, San Francisco, California
September 20-23	Twenty-first Annual Meeting of the Packaging Machinery Manufacturer's Institute, Skytop Lodge, Skytop, Pennsylvania.
October 12-14	Fifteenth Annual Forum of the Packaging Institute, New York City
October 12-14	Association of Official Agricultural Chemists, Washington, D. C.
November 2-4	Fall Meeting of the American Oil Chemists Society, Chicago.
June 27 to July 1, 1954	**Fourteenth Annual Meeting of the Institute of Food Technologists, Los Angeles, California**

(Information concerning future dates of national and international meetings, conventions and exhibits of interest to food technologists should be sent to the editorial office.)

New food laboratory vital part of expanded Eastman service



Troubled by
rancidity? changes in odor or flavor?
discoloration? brittleness?

If these quality-destroying problems are affecting your products and profits, Eastman's new food service laboratories may be able to help you.

Experienced Eastman personnel have at their disposal the latest scientific devices for studying and analyzing problems of oxidative deterioration in a wide variety of foods. We may have technical data already in our files on your particular problem.

Investigations have been completed or are under way on rancidity in shortenings, discoloration of meats, off flavor in milk, loss of potency in vitamin A, bitterness in citrus oils, brittleness in chewing gum, and the spoilage of candy, cereals, dog food, nut oils and a host of other products.

If you are having difficulty in holding food quality to specifications because of oxidative deterioration, send an adequate sample with a statement of the problem to Eastman Chemical Products Inc., Chemicals Division, Kingsport, Tennessee.

1. Checking appearance of unstabilized lard during AOM analysis.

2. Bank of Schaal ovens employed for accelerated shelf life tests for all types of food products.

3. Experimental paper coating machine to assist manufacturers on problems relating to rancidity and spoilage caused by oxidation.

4. Eastman food chemist dissolving antioxidant in blended shortening.

Tenox Eastman Food-grade Antioxidants

SALES OFFICES: Eastman Chemical Products, Inc., Kingsport, Tenn.; New York—260 Madison Ave.; Framingham, Mass.—65 Concord St.; Cleveland—Terminal Tower Bldg.; Chicago—360 N. Michigan Ave.; St. Louis—Continental Bldg.; Houston—412 Main St. **West Coast: Wilson Meyer Co.,** San Francisco—333 Montgomery St.; Los Angeles—4800 District Blvd.; Portland—520 S. W. Sixth Ave.; Seattle—821 Second Ave. **Canada: P. N. Soden Co., Ltd.,** Montreal, Quebec—2143 St. Patrick St.

Eastman
CHEMICAL PRODUCTS, INC.

Sales Representative for **TENNESSEE EASTMAN COMPANY,** Kingsport, Tennessee, division of **EASTMAN KODAK COMPANY.**

. . . *in the public interest*

An advisory group of the nation's leading scientists proposed 18 specific approaches for experimental work in the study of butterfat nutrition at a joint session with members of the American Dairy Association research committee held in Chicago in May. The suggested lines of investigation would involve experiments with human beings and laboratory animals supplemented with "test tube" chemical studies. The scientists stressed the desirability of placing the projects on a long-time basis because of newer knowledge now available in the nutrition field. It was pointed out that even a five-year plan could yield significant results at shorter intervals. The group recommended research investments in a few well-formulated and organized nutrition projects under expert supervision and adequate equipment rather than to support a large number of projects scattered at various institutions across the country. It was also brought out that selected nutrition projects should emphasize cooperation between scientists in related fields of investigation such as physiology, biochemistry, bacteriology, and others. Among approaches listed by the scientists are: relationship of dietary fats to longevity; effects of fats on utilization of other nutrients in the human diet; use of butterfat in reducing diets; high-fat pure vegetable fats in man compared to butterfat; proper protein-fat ratios in the diet; effects of heat on nutrients in butterfat and other fats; a study of quantity and quality of fats fed under conditions of stress; and an analysis of dietary habits in different portions of the world.

Front row, left to right, American Dairy Association research group: H. E. Dodge, committee chairman, Topeka, Kansas; Dr. Frank E. Rice, executive secretary, Evaporated Milk Association, Chicago; Dr. B. W. Fairbanks, executive director, American Dry Milk Institute, Chicago; Dr. J. A. Nelson, Montana State College, Bozeman; and Russell E. Frost, research director, American Dairy Association, Chicago.

Second row, left to right, scientists: Dr. Irvin E. Liener, University of Minnesota, St. Paul; Dr. Tom Hamilton, University of Illinois, Urbana; Dr. Zoe Anderson, director of research and nutrition service, National Dairy Council, Chicago; Dr. C. A. Elvehjem, University of Wisconsin, Madison; and Dr. Ancel Keys, University of Minnesota, Minneapolis.

Top row, left to right, scientists: Dr. T. W. Gullickson, University of Minnesota, St. Paul; Dr. Elmer Stotz, Medical School, University of Rochester, Rochester, New York; Dr. H. L. Sipple, executive secretary, Nutrition Foundation, Inc., New York City; Dr. George E. Holm, Bureau of Dairy Industry, U. S. Department of Agriculture, Washington, D. C.; and Dr. H. H. Williams, School of Nutrition, Cornell University, Ithaca, New York.

◆ ◆ ◆

The work of the Meals for Millions Foundation in introducing the three-cent meal of Multi-Purpose Food to a hungry world marks a milestone in a program in which the Gentry Division of Consolidated Grocers Corporation is proud to have played an important role from the beginning, George E. Clausen, Gentry's president, stated. Gentry manufactures Multi-Purpose Food exclusively for the non-profit Meals for Millions Foundation, and Gentry's biochemists contributed important modifications to the original formula developed by Dr. Henry Borsook, professor of biochemistry at the California Institute of Technology. The Gentry modifications reduced by one-third the original cost of the food, first called Multi-Purpose Meal, by substituting certain ingredients without sacrifice of nutritional values. Gentry also reduced the required cooking time from 30 minutes to ten. This was an important factor for food storage areas which were also fuel shortage areas. According to Mr. Clausen, Multi-Purpose Food is one of the few food products which is obtainable in 1953 at the same price as in 1945, and this has reportedly been made possible through constant improvement in manufacturing techniques in Gentry's plants. Mr. Nathan Cummings, company board chairman, has offered to expand production facilities and to extend credit wherever interested governments desire to utilize the benefits of Multi-Purpose Food on a nationwide scale. Mr. Roland Tognazzini, Consolidated vice president and also chairman of the American Relief for Korea Drive, pointed out that during the past two years, 2,309,768 meals have been sent to Korea through work of the Meals for Millions Foundation.

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Advance information on the processing behavior that may be expected of newly developed varieties of sugarcane will enable processors to adapt machinery and operations to meet difficulties that may arise when these canes are in commercial production. To obtain systematic information of the type needed, members of the Southern Regional Research Laboratory, USDA, New Orleans, La., during the past three grinding seasons processed juices from nine new varieties on a pilot-plant scale under conditions representative of commercial manufacture. Juices were collected quantitatively during the milling of two-to-three-ton lots of cane and were continuously processed for four to six hours at the rate of 50 to 60 gallons per hour. Samples of raw and clarified juices and sirups were withdrawn for analysis by accurate chemical methods, since chemical composition is closely related to processing behavior. Research will be continued at least one more season in an effort to develop methods of chemical analysis and tests of processing value to allow selection at an early stage in breeding programs of varieties that promise the smoothest factory operation and the best yields and quality of products. Availability of commercial cane of the best milling quality and processing performance will enable savings of several thousand dollars a day in the operation of any one large mill by assuring continuous grinding at maximum capacity throughout the season. For reprints of articles on this subject, written by SRRL scientists, write

(Continued on page 32)

Announcing

DOLCOURIN

"DOLCOURIN" ...a completely new flavor composition, is the result of the D&O Product Development Laboratories' concentrated efforts upon the Coumarin replacement problem. Non-alcoholic, high in fixative value, and approximately equal in flavor strength and tonal quality to Coumarin, "Dolcourin" is offered as a replacement suggestion to users of this material. "Dolcourin" contains no Coumarin or Coumarin derivatives whatsoever, and is suggested for use in any formula where Coumarin or Tonka are now employed as a complete or partial replacement. Tests have shown that the material blends well in Vanilla formulations and, in many instances may even be preferred to Coumarin. Price $2.50 per pound, in 25 pound quantities.

OUR 154TH YEAR OF SERVICE

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SALES OFFICES IN PRINCIPAL CITIES

ESSENTIAL OILS • AROMATIC CHEMICALS • PERFUME BASES • VANILLA • FLAVOR BASES

Food Industry Topics

(Continued from page 30)

Southern Regional Research Laboratory, 2100 Robert E. Lee Blvd., New Orleans, La.

For relief of refugees in Free Berlin, a carload of 48,000 cans of chicken broth has been donated by Continental Can Company and C. A. Swanson and Sons, Omaha, Neb., to was announced by Continental's board chairman, Gen. Lucius D. Clay. The shipment is the result of an appeal made earlier this year by Mayor Ernst Reuter of Berlin "for food especially for children who come to us undernourished." The shipment is being handled by the International Rescue Committee, Inc.

◆ ◆ ◆

The annual competition for U.S. Government Awards under the Fulbright Act for 1954-55 (Fulbright Scholarships) has been announced. The competition is for university lecturing and postdoctoral-level research in the following foreign countries: Austria, Belgium and Luxembourg, Denmark, Egypt, Finland, France, Germany, Greece, Iraq, Italy, Japan, Netherlands, Norway, Pakistan, Sweden, and United Kingdom and Colonial Dependencies. For complete information and application forms write: Conference Board of Associated Research Councils, Committee on International Exchange of Persons, 2101 Constitution Ave., Washington 25, D. C. Completed applications must be postmarked no later than October 15, 1953.

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Sugar Research Foundation, Inc., a non-profit corporation supported by raw sugar producers, cane sugar refiners and beet sugar processors in areas which are major contributors to the markets of the U. S. and Canada, marked its tenth anniversary by citing the following achievements from studies dealing with sugar: (1) development of sterile invert sugar, which is steadily supplanting glucose solutions in intravenous feeding; (2) production of a sugar-bearing ration for weaning pigs; (3) stimulation of the campaign to flouridate public water supplies; (4) spearheading studies of sugarcane wax; (5) stimulation of the use of molasses in green silage; (6) basic studies of molasses composition; (7) pointing up the importance of dextran, a product which can be made only from sugar, as a blood plasma substitute; (8) development of a process for making ascorbic acid from sugar beet pulp; (9) fundamental studies of the functions of sugar in various food technologies; (10) collation and summarization of the literature on sugar, its by-products and derivatives.

◆ ◆ ◆

Division of all research activities of the American Meat Institute Foundation into three specific areas of directional responsibility and the advancement of three staff scientists to serve as assistant directors of research in charge of these administrative sections has been announced by Mr. Wesley Hardenbergh, president. The Foundation, a not-for-profit sicentific research organization affiliated with The University of Chicago, maintains a research staff of 55 scientific and technically trained persons and is engaged in basic and developmental research related to production and processing of livestock and the utilization of products derived from livestock. Dr. Henry R. Kraybill, as director of research and education, continues in over-all administrative charge of the Foundation's research program. Responsible to Dr. Kraybill and directly supervising research within their areas of assignment are the following new assistant research directors: Dr. D. M. Doty, Dr. C. F. Niven, Jr., and Dr. B. S. Schweigert. Each of the new appointees is on the staff of The University of Chicago. Among their administrative functions will be the fostering of closer relationships with the University and expansion of the Foundation's work with University of Chicago graduate students interested in doing thesis work in the Foundation's fields of research interest.

◆ ◆ ◆

The Glycerine Producers' Association announces the second annual Glycerine Research Awards to recognize outstanding research accomplishment in the application of glycerine or glycerine derivatives. First Award consists of an honor plaque and $1000, Second Award an honor certificate and $300, Third Award an honor certificate and $200. Complete information, plus the official nomination blank, to be filled out by the candidate or in his behalf, is available from: Awards Committee, Glycerine Producers' Association, 295 Madison Ave., New York 17, N. Y. All nominations for the 1953 awards must be received by November 1, 1953.

◆ ◆ ◆

. . . *things new under the sun*

Corrosion in steam condensate systems—resulting from the presence of oxygen and acid carbon dioxide—now can be effectively controlled by use of a film-forming amine, Hagafilm, fed to the boiler in small amounts, on the order of two to three pounds per million pounds of steam. Hagafilm vaporizes with the steam in the boiler and deposits a very thin, non-wettable protective film on all metal surfaces wherever condensation occurs and throughout the return system. If only part of a return system needs this protection, the Hagafilm may be injected into the appropriate branch steam line. The material, supplied in both solid and liquid form, is safe for hospitals and other institutions where contact steam is employed to cook food and sterilize instruments. Copies of a new descriptive Hagafilm bulletin may be obtained from the Hagan Corp., Hagan Bldg., Pittsburgh 30, Pa.

◆ ◆ ◆

From Dodge & Olcott, Inc., 180 Varick St., New York City 14, comes this letter. "Undoubtedly the recent adverse reports on the use of Coumarin in food products have been a matter of some concern to you. As one of the largest and oldest suppliers of flavors and flavoring materials, it is understandably a matter of great importance to us also. You will, therefore, be glad to know that our laboratories have developed a new product . . . *Dolcourin* . . . which we are offering as a replacement suggestion for users of Coumarin. *Dolcourin* contains no Coumarin or Coumarin derivatives whatsoever. We suggest that it be used in any formula where you are now using Coumarin or Tonka as a partial or complete replacement. You should find *Dolcourin* to be high in fixative value and approximately equal in flavor strength and tonal quality to Coumarin. In order that you may have sufficient quantity to properly evaluate this interesting new product, we are offering *Dolcourin* in one pound trial bottles at the regular 25-pound price of $2.50 per pound. We will

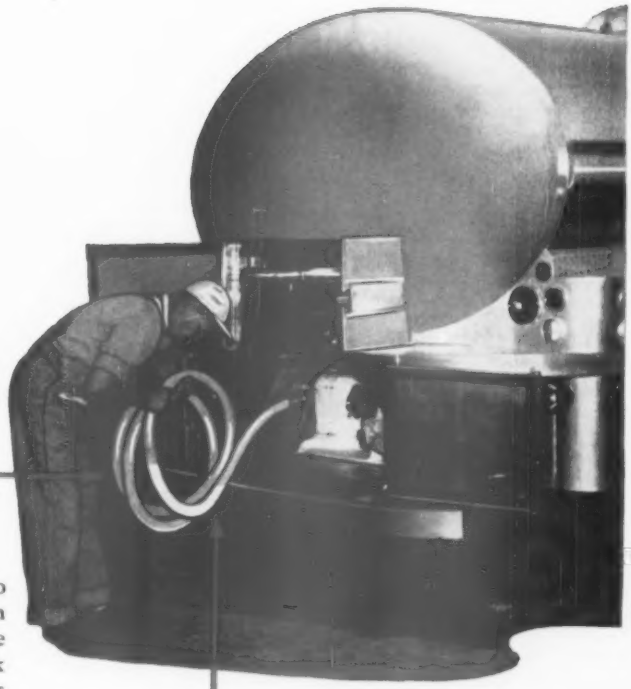
(Continued on page 34)

Safe EVEN FOR MILK!

TYGON

flexible plastic

TUBING



TYGON TUBING as used in the transfer of raw milk from trucks to storage tanks.

Raw milk is particularly sensitive to contamination. It readily picks up foreign tastes and odors. That's why especial care must be taken in the selection of milk handling and processing equipment. That's why TYGON Tubing is used as flexible piping on bulk milk trucks, milk dispensers, milking machines, and in general dairy applications.

TYGON Tubing is non-toxic and non-contaminating. It's been fully tested and approved by Boards of Health and the F. D. A. It's completely safe to use with milk or other sensitive foods and beverages.

Additionally, Tygon is easy and economical to use. It's light, strong, and fully flexible—goes from anywhere to anywhere. Its high translucency provides full solution visibility and accurate flow control. Its smooth surfaces stay smooth — flush clean easily. Its chemical resistance permits the use of strong cleaners or bactericides. Its non-oxidizing characteristics give it long life.

TYGON Tubing comes in continuous lengths and a wide variety of sizes ranging up to 2" ID. It also is available with plastic or stainless steel braided jacket reinforcement for use under pressures up to 300 psi.

Write, today, for more information. Ask for Bulletin T-77.

U. S. STONEWARE

PLASTICS AND SYNTHETICS DIVISION AKRON 9, OHIO

Food Industry Topics

(Continued from page 32)

supply *Dalcourin* without delay upon receipt of your order."

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A new ribbon-type indicating receiver for graphic panel use has been announced by the Foxboro Company, Foxboro, Mass., manufacturer of industrial instruments for process measurement and control. Added to the company's Consotrol line of compact instruments, the Model 50 Consotrol Indicator is especially suited to panel applications which require continuous indication of valve position or variables such as liquid level. The indicator receives pneumatic measurements from a transmitter located at the process. This force is applied to a sensitive receiver bellows which, through a lever and stainless steel tape arrangement, rotates two lightweight drums. A brightly colored Nylon tape, wound on the drums, is thus drawn behind a glass pane on which scale graduations are printed. The clearly defined readings make internal illumination unnecessary, thus simplifying installation and reducing maintenance, says the company. Since the indicator scale measures only 3¼" by 4¼", the instrument fits easily into graphic panel symbols.

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Flies that have become resistant to D. D. T. and other well-known insecticides can be killed economically by a new insecticide—malathon—announces American Cyanamid Company, 30 Rockefeller Plaza, New York 20, N. Y. Described by the USDA as "one of the safest insecticides to handle," malathon is a new, broad-spectrum insecticide introduced earlier this season as a killer of a wide range of farm and garden pests. Experiments now in progress indicate little likelihood of flies becoming resistant to malathon, even after prolonged use. Cyanamid is marketing malathon to many well-known manufacturers who, in turn, are marketing it under their own brand names. Labels on all brands clearly indicate whether they contain malathon. Pending the availability of further evidence, the company's agricultural experts advise against use of the product where milk is processed and stored, directly on animals, in dairy barns, or where feed and food products may become contaminated.

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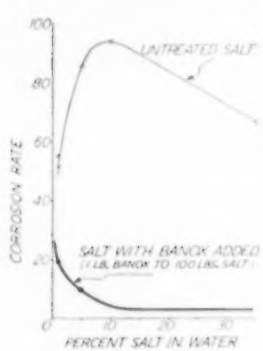
A new method of controlling corrosion and rust in salt brine refrigeration systems is announced by Calgon, Inc., Hagan Bldg., Pittsburgh 30, Pa. Use of the company's rust inhibitor, "Banox," in meat packing plants, dairies, breweries, cold storage plants, and refrigeration brine systems elsewhere has indicated that it effectively stops rust action. The product contains no chromates, alkalies, or acids and is odorless, non-poisonous, and non-toxic. It has reportedly proved harmless to the skin, eyes, clothing, paper, and paint finishes. The rust inhibitor, in dry powder form, is added with the salt cubes, granulated salt, or rock salt in a proportion of one pound Banox to 100 pounds salt when the refrigeration brine is prepared. Banox dissolves in the water along with the salt, and seeks out all metal and oxide surfaces, coating them with a microscopically thin complex phosphate coating which seals out oxygen and protects the metal from corrosion. Details on the use of Banox are contained in a folder, "Refrigeration Salt Brine Corrosion Control with Banox," available without obligation from Calgon, Inc.



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Installation of the first production model of the International Business Machines Corporation's newest and most powerful high-speed electronic calculator, the "701," at the company's world headquarters in New York City was announced recently. Designed to shatter the time barrier confronting technicians working on vital defense projects, the 701 is the first calculator of comparable capacity to be produced in quantity. A total of 18 will be built within a year, all consigned to Government agencies or defense industries. The calculators, which will rent for $11,900 monthly or more, depending upon storage capacity, will be used for the calculation of radiation effects in atomic energy; for aerodynamic computations for planes and guided missiles; on studies related to the effectiveness of various weapons; and on steam and gas turbine design calculations. One company will use the 701 to speed and simplify the immense task of assembling and interpreting production cost data from its several plants. In Government agencies, the 701 will be used principally on classified problems. The new computer, which can solve problems involving partial differential equations, ordinary differential equations, integral equations, matrices, and combinatorial analyses, has at least 25 times the over-all speed but is less than one-quarter the size of IBM's Selective Sequence Electronic Calculator.

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Chas. Pfizer & Co., Inc., have announced increases averaging nine percent in the basic prices of four citric acid products. The rises, the first in this line for Pfizer since 1948, are attributed by company officials to increased costs in manufacture. Under the new price schedule, Pfizer's citric acid U. S. P. is 2.5 cents per pound; anhydrous citric acid, 2.25 cents per pound; sodium citrate U. S. P., 1.5 cents per pound; and sodium citrate VIII, 3.5 cents per pound.

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A new line of polyethylene poultry bags is available to the industry. Round-bottom construction simplifies loading and provides a better "fit," while long top flaps provide for easier tying and greater length. Air-tight, moisture-proof, and unaffected by freezer temperatures, the bags are said to retain full freshness of the poultry, minimize shrinkage, and prevent freezer burns. They will not crack, split, or run, and are reportedly non-toxic, odorless, and tasteless. Available at low unit cost, the bags are adaptable to vacuum packing. For further information write Plastic Packaging Co., Dept. F4, 730 N. Franklin St., Chicago 10.

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Cherry-Burrell Corporation, 427 W. Randolph St., Chicago 6, announces a new, low-capacity, plate type heat exchanger selling for much less than standard models. The Model S1-30 "Superplate" Press can be used for the continuous heating or cooling of such products as milk, wine, soup, beverages, oils, and other liquid food and chemical products. An important feature of the press is the fact that the stainless steel plates used with it are the same as those provided for standard model "Superplate" presses. Therefore, when the capacity must be increased beyond the limits of this press, only the press need be replaced. The plates have a surface of many knobs which create turbulence and thereby provide rapid heat transfer. The company will be happy to provide further information.

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A new type of ice-maker producing hard, clear ice pebbles has been added to the Ajax line of ice making equipment, states

Food Industry Topics

a recent announcement from the Ajax Corporation of America, 2509 Washington Ave., Evansville, Ind. The machine, called the Ajax Pebble Ice Maker, is available in three capacities—200 lbs., 400 lbs., and 800 lbs. per day. The "pebble" ice made by the new machine, although similar to crushed ice, is dry and non-mushy.

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Dr. Foster D. Snell, president of the consulting chemical firm of Foster D. Snell, Inc., 29 W. 15th St., New York 11, N. Y., has announced results of a two-year research program on the cleaning of surfaces contaminated with radioactive debris. Such decontamination is necessary in the many laboratories working with radioactive isotopes, called "hot" labs, and will be necessary on a large scale in event of an atomic explosion at or near a populated area. Results of the study reveal that the major part of the decontamination can be accomplished with the aid of commercial soaps, light-duty synthetic detergents, and heavy-duty synthetic detergents, although the last-named was generally more effective than either of the other items in removing fission products from most surfaces. Some surfaces, notably plaster, require special treatment.

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Filamatic AB-F tradenames a new automatic fumigant dispenser recently introduced by the National Instrument Company, Baltimore, Md. The Filamatic will automatically deliver a single shot of any preset volume of liquid fumigant such as Acrylon into packaged food containers as they move along on the conveyor just prior to sealing. After the carton is sealed, the fumigant gasifies, destroying any existing infestation and preventing future contamination. Installation, says the company, is made easily on existing conveyor lines.

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. . . the literary corner

The Industrial Division of Minneapolis-Honeywell Regulator Company, Wayne and Windrim Aves., Philadelphia, Pa., sends word concerning new descriptive literature now available. Topping the list are three catalogs and a bulletin. Catalog 8950 (16 p.) describes, illustrates, and provides specifications for a wide variety of accessories for pneumatic control applications. Included are air-pressure regulators, air filters, pneumatic relays, control by-pass panels, pneumatic switches, valve positioners, and other highly functional equipment. Data on control piping systems are also included. Catalog 7001 (32 p.) describes many types of pressure and vacuum gauges used to measure vacuums as great as 10^{-11} mm. of mercury and pressures as great as 150,000 p.s.i. The catalog covers indicators, recorders, pneumatic and electric controllers, and pneumatic transmissions. Information is presented in tabular form for ready reference. Catalog 8305 (80 p.) describes and illustrates non-indicating electric, electronic, and pneumatic controllers for temperature, pressure, and humidity; also pneumatic and electric valves, switches, and relays. Bulletin 200-B is a complete alphabetical index of *Instrumentation*, quarterly publication of Honeywell's Industrial Divison. It contains: (1) a list

extend **SHELF LIFE!**

retard **RANCIDITY!**

...on High-Fat Low-Moisture Foods!

● As you know, potato chips, prepared mixes, nuts, baked goods, powdered soups and many other products that are high in fat and low in moisture are often spoiled by rancidity and the development of oxidative "off" flavors. And these factors reduce the shelf life and profit margin of many food products.

These problems may be avoided by the proper use of a new food grade salt with antioxidant, developed as a result of years of laboratory research—Diamond Crystal Salt with ANTIOXIDANT!

New Diamond Crystal Salt with *Antioxidant* is as simple to use as common table salt. If sodium chloride is used in your processing, this new salt will fit into your operation without extra equipment or labor.

Diamond Crystal Salt with *Antioxidant* is economical, too! The extra cost involved in salting potato chips is only about 7¢ per 100 lbs. of chips! This is a small cost to minimize returned goods.

The effectiveness, ease of use and economy of this new salt will more than justify its test in your operation. Samples are available upon request. Send for yours today!

Write to Technical Director, Diamond Crystal Salt Co., St. Clair, Michigan.

DIAMOND CRYSTAL SALT with Antioxidant

Food Industry Topics

of volumes and numbers published from 1943 through 1952; (2) an alphabetical index of all articles, by subject, published during this period; and (3) an alphabetical listing of all companies and institutions about which articles have been published. Bulletin 7302 describes the role of instruments in modern water, sewage, and waste treatment processes. Liberally illustrated with drawings and photographs of existing installations, the bulletin is a guide for organizing engineering thoughts on instrumentation of treatment processes. Several new instrumentation data sheets round out this month's Honeywell story. Data Sheet No. 3.6-7 describes the Mixer Consistency Recorder; No. 3.4-10 describes the Brown *ElectroniK* Control System for a Sto-Vac heater; No. 10.0-13 presents details on the Half-Second *ElectroniK* Recorder; No. 10.13-1a describes the Brown *ElectroniK* Recorder and Brookfield *Viscometran* which give a continuous indication and record of a material's viscosity under processing conditions. For any of this new Honeywell literature, write to Station 64 at the address as given above.

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The *Report* on the recent Southeastern Regional Meeting of the National Confectioners' Association at the Georgia Agricultural Experiment Station contains excellent accounts of the morning and afternoon sessions of the meeting. Subjects under consideration included: refrigeration of pecans, better peanuts, and problems in peanut staleness and rancidity. A merchandising and marketing seminar concluded the meeting.

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Michigan Chemical Corp., Saint Louis, Michigan, offers a new manual on fumigation techniques. Called *Pestmaster Fumigation Manual*, the 16-page illustrated book describes the most successful means of rodent and insect control in food and meat packing plants, warehouses, mills, box cars, vaults, bins, and other foodstuff storage areas. In each type of application, the preparation, equipment, and material required is outlined step-by-step and recommended dosages are listed in detail. The manual is available without cost or obligation by writing the company.

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Givaudan Flavors, Inc., 330 W. 42nd St., New York 36, N. Y., manufacturer of basic flavor materials, announces issuance of a new flavor publication, "*The Givaudan Flavorist*," designed to be an authoritative and objective source of information on problems related to the flavoring industry. Copies of the first issue and subsequent issues are available from the New York office of Givaudan. The company also announces issuance of a new, two-color, illustrated, 24-page catalogue listing and describing the various Givaudan flavor materials. The catalogue is divided into three sections: I: Basic Flavor Materials; II: Natural Fruit Flavors; and III: Imitation Flavors. Flavor materials in the third section are classified according to the suggested uses such as confections, soft drinks, ice cream, pharmaceuticals, and other industries. The first four pages of the Imitation Flavor Section are devoted to a master chart listing all the imitation flavors offered together with prices and concentrations for specific uses.

A new catalog, C-113, offered by American Sterilizer Company, Erie, Pa., describes the latest procedures in the sterilization of heat-and-moisture-sensitive items such as pharmaceuticals, packaged food products, surgical dressings, and bulk product materials such as wools, synthetic fibers, seeds, tobacco, etc. The new American cold process, which utilizes "Carboxide" gas as the sterilizing agent, is in use for plastic and rubber products, powders, delicate instruments, safety equipment, packaged dry goods and foods, and pharmaceuticals. Catalog C-113 includes diagrams, cross section views, and concise descriptions with engineering data to help in selection of proper sterilizer units for a wide range of bulk or packaged materials for industry.

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. . . conference room and meeting hall

American housewives have virtually reversed their milk buying habits during the past two decades, Mr. V. K. Shuttleworth, manager of the Dairy Division, American Can Company, told the 17th annual meeting of the International Association of Milk Control Agencies at Victoria, B. C. Where 95% of all packaged milk was formerly delivered to the home, today less than 45% of U. S. families get all their milk via the milkman, retail stores accounting for much of the difference. Production of paper milk containers, Shuttleworth reported, has increased more than ten-fold in the past 13 years—from 750 million units to 8.5 billion units. Another record is expected to be set in 1953, with the total paper units increasing another billion over last year.

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From the Refrigeration Research Foundation, 200 Midland Bldg., Colorado Springs, Colo., comes news of the recent annual meeting held in Washington, D. C. Officers elected for the coming year were: Dr. S. C. Prescott, chairman, Board of Governors; Mr. W. A. Sizer, president; Mr. H. J. Nissen, vice president; Mr. W. A. Kopke, treasurer; Mr. K. F. Stepleton, asst. secretary; and Mr. H. C. Diehl, director and secretary. Projects reviewed at the meeting included those dealing with frost heaving, low-temperature psychrometry, citrus storage, ammonia damage, scald temperatures for turkeys, and storage volatiles. Dr. Prescott delivered the principal address, devoted to a review of the functions and accomplishments of the Foundation during the ten years since its organization in 1943.

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The Fritzsche Flavor Booth at the IFT Convention featured more than 200 different flavoring compounds representing a cross section of the 82-year-old firm's flavoring specialties for food and beverage products. Fritzsche Brothers also used this exhibit as the occasion for introducing their convenient, newly-devised Flavor Data Sheets and Flavor File Folders. These provide—in separate, detailed forms—brief, useful information covering a number of the firm's many catalogued products. Each sheet presents, completely and concisely, the important data relating to a single group of flavors. Sets of these Flavor Sheets will be mailed to anyone writing Fritzsche Brothers, Inc., Port Authority Bldg., New York City, or any one of the firm's sales representatives.

Food Industry Topics

Officers of the American Oil Chemists' Society, to serve from May 1953 to May 1954, were announced as follows subsequent to election at the recent annual meeting of the Society in New Orleans: president, Procter Thompson, Procter and Gamble Co., Cincinnati; vice president, Chas. E. Morris, Armour and Company, Chicago; secretary, T. H. Hopper, Southern Regional Research Laboratory, New Orleans; treasurer, A. F. Kapecki, Wurster and Sanger Inc., Chicago. Scheduled for the near future by the Society is the 27th annual fall meeting in Chicago at the Sherman Hotel, November 2-4, with Mr. Kapecki as chairman. General topics under consideration for the program are margarine, industrial and engineering processes, use of fats in animal feeding, drying oils, soaps, etc.

Canners should cooperate in educating consumers on the benefits of canned foods, and in more commodity promotions, according to speakers at the third annual institute on sales training for the canning industry at the University of Wisconsin, held in May. Jointly sponsored by the university, Wisconsin Canners Assn., and Wisconsin Manufacturers Assn., the institute featured spokesmen from wholesaling, retailing, and national canning associations.

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. . . building up and branching out

Morton Packing Company, Louisville, Ky., has greatly increased its production capacity by acquiring the complete manufacturing and cold storage plant of the Crozet Cold Storage Co., Crozet, Va., it was announced by Mr. George E. Egger, president of Morton. The new plant will be used to manufacture Morton's Frozen Beef Pot Pie, Turkey Pot Pie, and Chicken Pot Pie as well as Morton's Frozen Apple and Cherry Pies for customers in the East and Southeast.

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In chemical and food processing industry applications, the Merco Centrifugal Co., San Francisco, is now sales representative for Centrice, Inc., Englewood, N. J., sole distributor for Westfalia Separator, A. G. of Oelde, Germany. Westfalia manufactures a wide line of industrial centrifuges of the following types: liquid-liquid separators, liquid-solid separators, clarifiers, extractors, and liquid-liquid-solid separators.

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GLORIZE, National Starch Products' dough conditioner, will now be distributed solely by H. C. Brill Co., Inc., Newark, N. J., according to Mr. Don Pascal, National Starch vice president and sales manager. Glorize was introduced by National to the baking industry last year. Nationally known in the baking industry for 25 years, H. C. Brill, Inc., markets such products as KWIKAKE mix, SHORTO, Pan-EASE, BITTERSWEET icing base, and a wide variety of pie fillings, toppings, and flavors. According to National Starch, this new distributing arrangement should insure the baking industry prompt and efficient service on Glorize. H. C. Brill, Inc., are well equipped with many centrally located warehouses, and a complete staff to effectively handle any technical or plant production problem.

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A modern new sensory panel laboratory in which the newest methods are employed for the scientific analysis of flavor and odor is the subject of a brochure, "Scien-

(Continued on page 39)

DIVERSEY *Announces*

Exclusive New Divomatic

ELECTRONIC SOLUTION CONTROL FOR BOTTLE WASHING

New DIVOMATIC assures maximum efficiency from your bottle washing machine. New 52" electronic control cell* is foolproof. You get accuracy never before possible . . . amazing dollar savings in actual tests. Get the facts on how you can have better bottle washing at lower costs with new Diversey DIVOMATIC electronic solution control. Call your Diversey D-Man or write today for full information.

Cleaner Bottles

for Louisville plant. "Ever since Divomatic was installed," says the chief chemist, "we have had more uniformly clean, as well as cleaner bottles."

Reduces upkeep 36.8%

for Chicago plant in actual test. Over 1500 pounds of washing material saved each month.

Saves 326 lbs. of material per day

for Kansas City, Mo., plant. DIVOMATIC pays for itself in a short time in many installations.

For full information see your Diversey D-Man

Divomatic offers

- ★ ELECTRONIC TITRATION
- ★ AUTOMATIC FEEDING
- ★ ADDS INITIAL CHARGE (B-1 Only)
- ★ MAINTAINS CONSTANT STRENGTH
- ★ SAVES LABOR AND MATERIALS

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Divomatic BC for Average Capacity Bottle Washing Machines

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MEMBERSHIP

Write to nearest regional secretary, if within an area covered by a regional section, or to the Executive Secretary of the Institute, for an application form and information regarding qualifications and classifications.

Food Industry Topics

(Continued from page 37)

tific Analysis of Flavor and Odor," available from the Evans Research and Development Corp., 250 E. 43 St., New York 17, N. Y. According to the company, "Flavor and odor are no longer 'intangibles.' Identification and modification of these factors is now possible. Investigation may well help to improve products, thereby contributing to increased sales and profits." The brochure summarizes some of the ways in which the Evans scientific research technique can be put to use.

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. . . the human element

In a ceremony held at the National Dairy Research Laboratories, Inc., Oakdale, Long Island, N. Y., five members of the Laboratory staff were honored on June 12 by their associates for their outstanding contributions to scientific progress. The function, a Recognition Assembly, was presided over by Dr. L. B. Hitchcock, president. Dr. A. H. Johnson, vice president, presented the awards. Two research fellowships were established giving greater freedom of action to the scientists so honored. The fields of investigation of the recipients are open to their own choosing. The two Fellows appointed were Dr. E. H. Freund and Dr. G. H. Haugaard. For outstanding research in the application of enzymology to human and animal nutrition, the National Dairy Research Laboratories' Achievement Award was shared by Dr. E. G. Stimpson and Mr. Harold Yound. Dr. H. G. Harding has been elected to the rank of senior scientist of the Laboratories for his outstanding accomplishments in the field of detergents and sanitizers.

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The formal retirement of Mr. Francis L. Mead, who was responsible for many improvements in the current processes used for production of citric acid by Chas. Pfizer & Co., has been announced. Mr. Mead joined Pfizer in 1920 during the period when the firm was pioneering in the production of citric acid by the fermentation process. During his long career with Pfizer, Mr. Mead served as manager of citric acid recovery and more recently as new product manager. With his vast experience in the production of citric acid, Mr. Mead was in considerable demand as a consultant. He took an active part in the construction of Pfizer's modern citric acid plant at Groton, Conn.

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Mr. Louis Ehrenfeld, 933 Avondale Ave., Cincinnati, Ohio, a charter member of the IFT, formerly technical consultant of the Redtop Brewing Company, has announced the opening of his own engineering consulting practice, specializing in installation of maintenance systems and general facilities engineering.

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Mr. John B. Calkin, chemical engineer and consultant with offices in New York City, has been named assistant to the president, Foster D. Snell, Inc., 29 W. 15th St., New York City. He will also be director of market research. This appointment follows a long-time connection of Mr. Calkin with the firm. He has recently been

HOW
KLENZADE
CAN HELP YOU SOLVE
Your
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Food Industry Topics

associated with the University of Maine where he was director of the Department of Industrial Cooperation and secretary, the University of Maine Pulp & Paper Foundation. He is an associate professor of chemical engineering.

◆ ◆ ◆

Food Machinery and Chemical Corporation, San Jose, Calif., has announced that Mr. Jan Oostermeyer, who retired as president of Shell Chemical Corporation on June 1, has been elected to its Board of Directors. Mr. Oostermeyer, a leading authority in the petrochemical field, developed and directed Shell Chemical's $50,000,000 program in petrochemicals, including the first commercial production of synthetic glycerine. Mr. Paul L. Davies, FMC president, stated that Mr. Oostermeyer's broad technical knowledge and executive leadership would make him an exceedingly valuable member of the company's board.

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Professor Bernard E. Proctor, head of the Food Technology Dept., Massachusetts Institute of Technology and president of the Institute of Food Technologists, has been elected to the Board of Directors of National Phoenix Industries, Inc., it has been announced by Mr. Walter S. Mack, president of that corporation. During the war, Dr. Proctor was director of Food and Packaging Research for the Office of The Quartermaster General. National Phoenix Industries, Inc., is holding company for Cantrell & Cochrane Corp., manufacturers of C&C "Super" drinks—first line of soft drinks to be marketed in cans.

◆ ◆ ◆

Dr. Lloyd A. Hall, technical director, The Griffith Laboratories, Inc., Chicago, has been elected chairman-elect of the Chicago Chapter, American Institute of Chemists. Dr. Hall is a charter member of the IFT and has served as a member of the Executive Council and is presently councillor at large.

◆ ◆ ◆

Mr. William J. Mahan, an IFT member, who has been associated with the food industry since 1941, has been named assistant to Mr. Charles W. Kaufman, vice president and director of research of the Kraft Foods Company. He was previously technical director for the Diamond Crystal Salt Company, St. Clair, Michigan.

◆ ◆ ◆

From American Can Company comes two significant personnel notes. Mr. William J. Fairnington of Tampa, Fla., has been appointed manager of the company's new multi-million-dollar can-making plant at Plymouth, Fla., and Mr. Raymond J. Odiorne, Baltimore, Md.,

Food Industry Topics

is the newly appointed manager of the new American Can Co. can-making plant in Lemoyne, Pa. The announcements were made by Mr. R. B. Thompson, manager of manufacture for Canco's Atlantic Division. The 220,000 square-foot Florida plant will manufacture millions of cans annually for the expanding Florida citrus canning industry after it begins operation late this year or early in 1954. The Lemoyne, Pa., plant is expected to employ over 450 persons when in full operation.

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Dr. Andrew C. Rice, an IFT member, formerly of the New York State Experiment Station at Geneva, N. Y., has been named technical director of the Seneca Grape Juice Corp., Dundee, N. Y., according to an announcement made by Mr. Kenneth Holgate, production manager. Dr. Rice will be in charge of Research and Quality Control at the company's plants in Dundee and Penn Yan. His efforts will be directed toward development of new products and methods, and the maintenance of uniformly high quality standards.

◆ ◆ ◆

Dr. Frank L. Gunderson, a member of IFT, food research consultant, announces a change of address to 1003 DuPont Circle Bldg., Washington 6, D. C. Telephone: Hobart 2-2226.

CALIFORNIA BIOLOGISTS ALARMED AT PACIFIC MACKEREL SCARCITY

The Pacific mackerel (*Pneumatophorus diego*), the basis of a one-time multimillion dollar fishery, has pulled a disappearing act which alarms marine biologists of the California Department of Fish and Game, according to a March 12 news release from that Department. Recent commercial landings of Pacific mackerel at California ports are the lowest since 1932. Symptoms of a sick fishery have been diagnosed by the State specialists for several years.

Los Angeles has always been the center of the mackerel fishery, with Newport Beach an important harbor since 1935. First the lampara and then the purse-seine fleet dominated the fishery at Los Angeles.

Newport Beach was the base for the small-boat operator, employing the technique of "sticker" fishing from which evolved the technique of "scooping." By the late 1930's the seine fleet was no longer able to meet the demands of Los Angeles harbor canneries and the small-boat fishery expanded tremendously. Despite this, the trend of the catch has continued downward.

The mackerel catch, canned almost entirely in southern California, has been a staple diet item among low-income Americans generally throughout the South, and in the Philippines.

During their abundance, the Pacific mackerel were fished from May through the winter. In recent years, most of the fishing has been concentrated between Labor Day and Christmas. The 1951 season, however, ended in early November. There just weren't any Pacific mackerel to catch. [From *Commercial Fisheries Review*, **14**, (4) 25 (1952) April.]

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Fairmont Foods Company, Omaha, Nebraska, announces the election of two new members to its board of directors. New directors are Mr. John F. Merriam, Omaha, president of Northern Natural Gas Company and a director of several large corporations, and Mr. Eugene Holland, Chicago, founder of the Holland Lumber Company and a director of the Gulf Mobile and Ohio Railroad and the Illinois State Chamber of Commerce.

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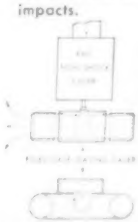

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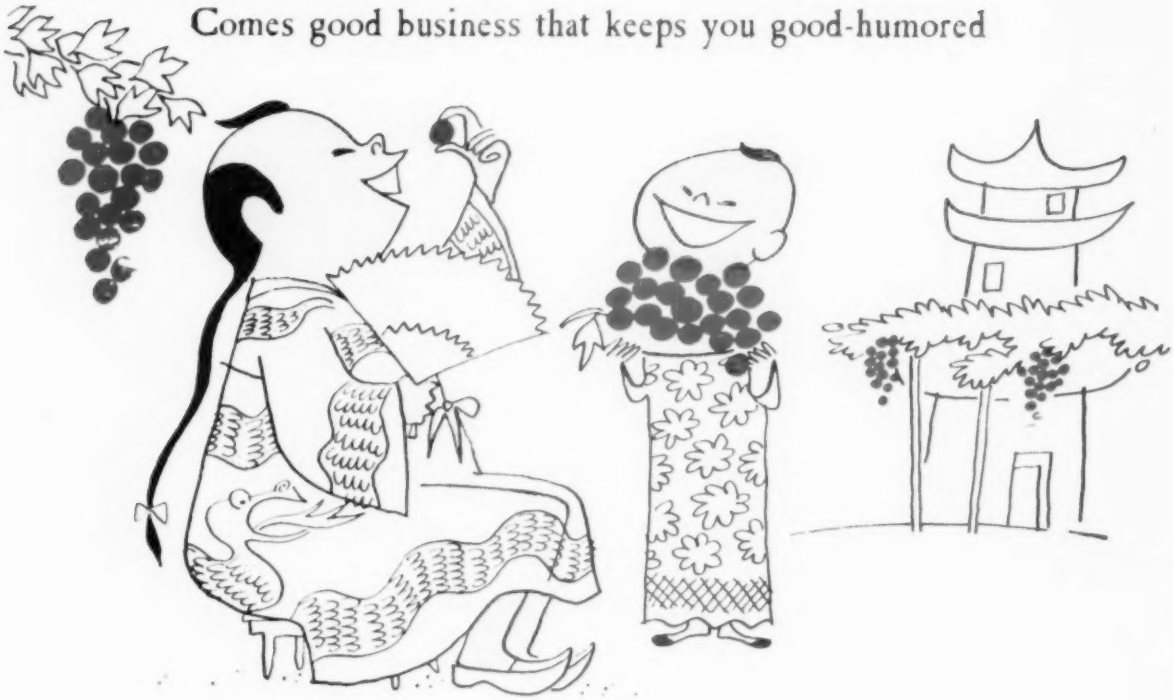

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